

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY
ATLANTA, GEORGIA 30333

HEALTH STUDY OF COMMUNITIES SURROUNDING
OTIS AIR NATIONAL GUARD BASE/CAMP EDWARDS
FALMOUTH, MASSACHUSETTS

FINAL REPORT
DRAFT FOR PUBLIC COMMENT

Please address comments by August 23, 1996 to:

Sara M. Sarasua, MSPH
ATSDR MS E-31
1600 Clifton Road, NE
Atlanta, Georgia 30333

July 1996

DISCLAIMER

Mention of the name of any company or product does not constitute endorsement by the Agency for Toxic Substances and Disease Registry, the Public Health Service, or the U.S. Department of Health and Human Services.

CONTENTS

	page
DISCLAIMER	ii
LIST OF TABLES	v
LIST OF FIGURES	viii
COMMUNITY SUMMARY	x
ABSTRACT	1
INTRODUCTION	5
PURPOSE	9
Study Objectives	9
Rationale for Study Design	10
METHODS	12
Summary of Study Methods	12
Selection of the Target Population	13
Selection of a Comparison Population	13
Sample Size and Power Estimates	14
Eligibility Criteria	15
Sampling Algorithm	16
Data Collection	18
Reimbursement for Participation	18
Interview	18
Collection of Biologic Specimens	19
Participants' Notification of Test Results	21
Data Analysis	21
Laboratory Test Analysis	27
Community Involvement and Notification	30
RESULTS	31
Census	31
Participation Rates	31
Demographic Characteristics of Target and Comparison Area Participants	33
Well Water Consumption	34
Blood Lead Levels	35
Symptoms and Illnesses	36

Comparison of Symptom and Illness Results from 1993 to 1994	36
Illnesses and Symptoms among Combined Water/Air Pathway Areas versus Comparison Area	37
Combined Air-Only Pathway Versus Comparison Area	39
Analysis of Occupations of Study Participants	41
Power and Sample Size	43
Subjective Analysis	45
Symptoms and Illnesses Among Children 8 Through 14 Years of Age . . .	48
Analysis of Symptoms and Illnesses in Each Individual Target Area . . .	49
Reported Symptoms and Illnesses Among Well Water Users	60
Reproductive Outcomes	61
Laboratory Test Results	62
Comparison of 1993 and 1994 laboratory data	62
Results of Tests by Organ System	63
Hematologic (Blood) Tests	63
Kidney Tests	64
Immune System Tests	66
Liver Test Results	69
Laboratory Test Results by Community	70
Summary of Laboratory Test Results	71
Agreement Between Self-Reported Health Conditions and Related Medical Tests	72
DISCUSSION	74
Study Strengths	74
Study Limitations	75
Interpretation	81
CONCLUSIONS	95
RECOMMENDATIONS	100
AUTHORS AND ACKNOWLEDGEMENTS	101
REFERENCES	102
TABLES	105
FIGURES	177
APPENDIX	193

LIST OF TABLES

Table 1.—Age distribution applied to stratified sampling for selecting residents to participate in the health study.	106
Table 2.—Comparison of demographic characteristics between total eligible residents and study participants in each study area.	107
Table 3.—Demographic characteristics for target and comparison area study participants	108
Table 4.—Comparison of well water use among the five study areas.	109
Table 5.—Comparison of recent water use among the four target areas and the comparison area.	110
Table 6.—Comparison of blood lead levels between the four target areas and the comparison area.	111
Table 7. Comparison of reports of health conditions in the 1994 data collection period compared to the 1993 data collection period, comparison area participants only.	112
Table 8.—Comparison of the number of participants from the target areas with water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of illness since they moved to their homes.	114
Table 9.—Comparison of the number of participants from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of symptoms since they moved to their homes.	117
Table 10.—Comparison of the number of participants from the target areas with water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently (at the time of data collection) had an illness.	119
Table 11.—Comparison of the number of participants from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas	

with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently have symptom.	122
Table 12.—Most recent occupations of study participants.	124
Table 13.—Most recent industry of participants	125
Table 14.—Comparison of numbers of persons having a current or most recent job with potential chemical exposure or associated with the Massachusetts Military Reservation.	126
Table 15.—Comparison of responses to subjective question for participants aged 12 years or older.	127
Table 16.—Effect of being worried or concerned about neighborhood environmental or chemical hazards on reporting of illnesses with first onset since moved to current home, among participants ages 12 through 75 years of age.	128
Table 17.—Effect of Subjective Questions on reporting of current illness among participants ages 12 to 75 years.	132
Table 18.—Comparison of the number of child participants aged 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of illness since they moved to their current homes.	136
Table 19.—Comparison of the number of child participants aged 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of symptoms since they moved to their current homes.	138
Table 20.—Comparison of the number of child participants ages 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently had an illness.	140
Table 21.—Comparison of the number of child participants age 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently had a symptom.	142

Table 22.—Comparison of the number of participants in each study area who had first onset of illness since moving to their current homes	144
Table 23.—Comparison of the number of participants in each study area who had first onset of symptoms since they moved to their homes	148
Table 24.—Comparison of the number of participants in each study area who currently had illness	150
Table 25.—Comparison of the number of participant in each study area who currently have symptoms	153
Table 26.—Summary of illnesses with elevated* or decreased† odds ratios for each target area versus comparison area, by definition of illness	155
Table 27.—Summary of symptoms with elevated* or decreased† ORs for each target area versus comparison area, by definition of symptom	156
Table 28.—Comparison of the effect of dropping persons who reported never using well water from analysis of illnesses with first onset since moving to the current home	157
Table 29.—Comparison of the effect of dropping persons who reported never using well water from analysis of symptoms with first onset since moving to the current home	158
Table 30.—Comparison of the effect of dropping persons who reported never using well water from analysis of current illnesses	159
Table 31.—Comparison of the effect of dropping persons who reported never using well water from analysis of current symptoms.	160
Table 32.—Comparison of reproductive outcomes among women aged 15 years or older who have ever been pregnant.	161
Table 33.—Comparison of mean biomarker results for water/air pathway target areas and comparison area, 1993 data collection only.	162
Table 34.—Comparison of mean biomarker results for air-only pathway target areas and comparison area, 1993 and 1994 data collection phases combined.	165

Table 35.—Results of medical tests for the two communities with water pathways around Otis ANGB/Camp Edwards and the comparison community, May and June, 1993, including all participants regardless of current health.	168
Table 36.—Results of medical tests for the two communities with air-only pathways around Otis ANGB/Camp Edwards and the comparison community, 1993 and 1994, including all participants regardless of current health.	170
Table 37.—Results of medical tests for the two communities with air and water pathways around Otis ANGB/Camp Edwards and the comparison community, 1993 and 1994.	172
Table 38.—Summary of medical test results where there was a two-fold or greater difference in proportion of participants outside of the reference range or where there was a statistically significant difference in mean test values.	175

LIST OF FIGURES

Figure 1. Study area	178
Figure 2. Study area boundaries for Ashumet Valley, Falmouth	180
Figure 3. Study area boundaries for Briarwood, Mashpee	182
Figure 4. Study area boundaries for Forestdale, Sandwich	184
Figure 5. Study area boundaries for Picture Lakes, Bourne	186
Figure 6. Study area boundaries for the comparison area	188
Figure 7: Map of study areas around the MMR, location of study participants and location of groundwater plumes	190
Figure 8. Biologic Tests Used to Measure the Liver, Kidney, and Immune Systems . .	192

PREFACE

In January 1995, Part I of this study was released as a draft for public comment. This report combines Part I (data collected in May and June 1993) and Part II (data collected in October 1994) in order to be more comprehensive and its content more meaningful than releasing results in several parts. The Part I draft for public comment included only the results of the study of symptoms and illnesses among the original 600 participants. This report includes the following: results from all 900 participants from the 1993 and 1994 data collection efforts; an analysis comparing the two years of data to determine how similar they are and if they could be combined; analysis of symptoms and diseases to look not only at conditions with first onset since the participant moved to his or her current home but also to include current health conditions; additional analyses examined potential effects of occupation; more tables and documentation of analyses; a subanalysis to examine persons in the ground water pathways, restricted to just those who had ever used well water; results of the medical tests; and a map to note where participants lived in relation to groundwater plumes and the Massachusetts Military Reservation.

COMMUNITY SUMMARY

This section guides the reader through the technical report. It describes how the study was done and summarizes the results. It also describes issues that the reader should be aware of when interpreting the findings of the study.

INTRODUCTION

Otis Air National Guard Base (OANGB)/Camp Edwards is part of the 22,000-acre Massachusetts Military Reservation (MMR) located on upper Cape Cod where on-base groundwater contamination has resulted in contamination of private residential and public wells near the base. Contaminants found included fuel-related compounds, volatile organic compounds (VOCs), and lead. Concerns expressed by communities near the MMR included possible health effects resulting from these contaminants in the groundwater and surface water and emissions from past artillery propellant powder bag burning activities. This study was designed to assess the health status of residents living near the MMR compared with that of residents living in a comparable community without chemicals.

STUDY DESIGN AND METHODS

In April and May 1993, a door-to-door census was taken of four communities located near the MMR and a similar unexposed comparison community (Brewster). This was done to get a complete list of everyone who lived in the areas. Ashumet Valley in Falmouth and

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Briarwood in Mashpee were the two communities near the MMR which had contaminated groundwater plumes and potentially airborne contaminants. Forestdale in Sandwich and Picture Lakes in Bourne were included due to community concern about potential exposure to airborne contaminants. A sample of residents was selected from the census lists in each community and invited to participate in the study.

To be eligible to participate, residents had to be full-time residents (not seasonal or weekend-only), be between 8 and 75 years of age, and have lived in their homes for at least 8 years (the time when contaminated water was discovered). When there were not enough residents meeting the 8-year residency requirement to obtain the desired sample size (100 people in each target area and 200 people in the comparison area), the criteria was relaxed to 1 year residency.

A total of 605 people participated in the study in May and June 1993. At the request of the community, an additional 303 persons were added to the study in October 1994 from Forestdale (102 additional people), Picture Lakes (98 additional people) and the comparison area (103 additional people) with the purpose of increasing the number of people in the study to be able to look at health effects in the individual target areas. Therefore, 908 people in the community were tested. About half of the people who were contacted and invited to participate agreed to be part of the study. The 908 people who participated answered questions from a questionnaire and provided blood and urine specimens during the two years

of data collection. The questionnaire asked about self-reported illnesses and symptoms and women's reproductive histories. The questionnaire asked questions such as "has a physician or other medical provider ever told you that you had [illness]." Symptoms were asked "Have you ever had [symptom]." The dates that the participant first had the condition and last had the condition were also asked. The date that a participant moved into their home was asked as well. The health of participants was measured in two ways: (1) participants currently having a condition at the time of interview (referred to as "current" health conditions for the remainder of the report) and (2) having first onset of a condition since the participant moved to his or her residence. The first measure was done to assess current symptom and illness burden in the target areas relative to the comparison area. The second measure ensured that conditions existing before the exposure (moving to the area of residence) occurred would not obscure possible exposure-induced illness.

The study compared the number of people reporting health conditions in each community compared to the comparison community. Most all of the conditions were reported in every community, including the comparison community. By using a comparison community, the study could show which conditions appeared to be reported more often in the target community.

The investigators focused on health conditions that were reported twice as often or more in the communities near the MMR as compared to the comparison area or conditions

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

that were reported statistically significantly more than those in the comparison area (p value < 0.1)— This means that they were less likely to have occurred by chance. The interview asked about 24 different illnesses and 14 symptoms. In addition, blood lead levels and 21 different medical tests (of the kidney, liver, and immune system) were measured and compared between communities by comparing average (mean) test levels and comparing the proportion with test results outside of the normal range.

The investigators focused on test results which were statistically significant or which had twice as many outside the reference range as in the comparison area. The pattern of test results were also examined. For instance, if kidney disease were a problem in an area, one would expect several of the kidney tests to be outside of the reference range. If a single test was outside the reference range, it was considered more likely to represent normal variation.

Associations between community of residence and reported health conditions were evaluated using a statistic called the odds ratio. The odds ratio (OR) estimates the ratio of disease in the target community compared to disease in the comparison area. An OR of 1.0 indicates about the same reports of illness in the target area as in the comparison area. An OR greater than 1.0 indicated a higher reported amount of disease in the target area, while an OR less than 1.0 indicated a lower amount in the target area than in the comparison area. An OR of 2.0 indicates a two-fold higher reported amount in the target area. An OR of 0.5 indicates half the amount in the target area compared to the comparison area.

RESULTS AND CONCLUSIONS OF THE STUDY

Description of People Participating in the Study

Target and comparison area participants were similar in terms of age, sex, and race (see Table 3). Participants from the Briarwood community had lived in their homes for less time than participants from the other communities. The average number of years participants from Briarwood had lived in their homes was 9.0 years compared with 11.7 years in the comparison area, 11.1 years in Forestdale, 13.4 years in Ashumet Valley, and 13.4 years in Picture Lakes. These differences could be important when comparing the number of people who had first onset of a condition after moving to their home compared to the comparison area because the longer a person lives in a place, the more time for a potential health condition to develop during that time.

Well Water Consumption

A large majority (more than 88%) of participants from the two communities with contaminated groundwater plumes (Ashumet Valley and Briarwood) said that their households had once used well water as the primary source of drinking, cooking, and bathing water (Table 4). At the time of interview, one participant in Ashumet Valley and 26 participants in Briarwood indicated they had used private well water within the 60 days prior to the interview (Table 5).

Blood lead levels

Blood lead levels were similar among the five communities (averages ranged from 2.7 to 3.2 micrograms of lead per deciliter of blood, $\mu\text{g/dL}$) and were similar to national average (see Table 6). All children tested had blood lead levels less than 10 $\mu\text{g/dL}$, the Centers for Disease Control and Prevention action level (¹).

Reported Adverse Pregnancy Outcomes

Similar numbers of adverse pregnancy outcomes were reported in the target and comparison areas.

Symptoms and Illnesses Among Children 8 Through 14 Years of Age

Children in the water/air pathway areas (Ashumet Valley and Briarwood) reported having more hayfever; eczema or other skin problems; numbness or the sensation of pins and needles in fingers and toes; headaches; trouble sleeping; watery, burning, or irritated eyes; and rashes than children in the comparison area.

Children in the air-only areas (Forestdale and Picture Lakes) reported more tingling or prickling in fingers or toes; numbness; neurologic or nervous system problems; trouble sleeping; and headaches than children in the comparison area. However, half as many of these children reported watery, burning, or irritated eyes; nausea; or poor coordination as did children in the comparison area.

Symptoms and Illness reports by target area

The reports of symptoms and illnesses were assessed for each of the four target areas individually (Tables 22-25). Twenty four self-reported, physician-diagnosed illnesses and 14 symptoms were assessed for each area. Tables 26 and 27 in the technical report summarize illnesses and symptoms which were reported at least twice as often compared to the comparison area, or conditions which were reported statistically significantly more often than in the comparison area.

Laboratory tests

The results of the laboratory tests were assessed by comparing average (mean) values in the target areas to those in the comparison area (Tables 33 and 34) and by comparing the percentage of participants with test results above or below a given reference range in the target areas to the comparison area (Tables 35 through 37). Tests which were statistically significantly different or which had a two-fold or greater difference between target and comparison are summarized in Table 38. Patterns were examined to see if more than one test in a panel was increased or decreased and to compare the number of tests which were increased versus the number decreased between the target and comparison areas.

Analyses by Neighborhood

Ashumet Valley

Eleven of twenty four self-reported illnesses, with first onset since the participants moved to their homes were reported more often among Ashumet Valley participants than among comparison area participants. Six of the conditions were statistically significantly higher in Ashumet Valley than in the comparison area: frequent periods of anxiety, nervousness, or depression; hayfever or other respiratory allergy; pneumonia; thyroid disease; anemia; and arthritis, rheumatism or other joint disease. The five other conditions, which were not statistically significant, were reported twice as much in Ashumet Valley than the comparison area: heart disease; chronic bronchitis; ulcers or other stomach disease; bowel or intestinal problems; urinary tract disease; and cancers of the blood.

When people were asked about conditions they currently have, people in Ashumet Valley reported having four health conditions substantially more than comparison area residents. These conditions were chronic bronchitis, ulcers or other stomach disease, bowel or intestinal problems and arthritis or other joint disease. Two of these conditions (arthritis and chronic bronchitis) were statistically significant.

Possible factors related to the large number of reported health conditions, with first onset after moving into the current home, could have been due to past exposure to

contaminated groundwater, the greater number of years Ashumet Valley participants had lived in their homes (average of 13.4 years) compared to those in the comparison area (average of 11.7 years), differences in recall of health conditions between persons living in Ashumet Valley and the comparison area, or other reasons. Some of these findings (ulcers, cancers of the blood) were based on very few cases of illness and might be more susceptible to chance variations. By the time of the study, the health of participants from Ashumet Valley was similar to that of comparison area participants, other than the four chronic conditions mentioned above.

The study also compared the medical test results, and did not find evidence of organ damage or dysfunction.

Briarwood

Participants living in the Briarwood area reported four types of illnesses (with first onset since participants moved to their current homes) more often than did participants from the comparison area: tremors or shakes; hayfever or other respiratory allergy; pneumonia; and ulcers or other stomach disease. Pneumonia was the only statistically significant finding. Five current (at the time of the study) health conditions were reported by Briarwood participants more often than by comparison area participants (weakness or numbness, chronic bronchitis, ulcers or other stomach disease, urinary tract disease, and arthritis [arthritis was the only statistically significant finding]). Two types of current symptoms and 5 symptoms

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

with first onset since participants moved to their current homes were reported more often by Briarwood participants than comparison area participants.

Participants from Briarwood reported somewhat more than expected (relative to the comparison area) numbers of illnesses with first onset since participants moved to their homes and current health conditions. Possible factors related to these findings could have been past exposure to contaminated groundwater, differences in recall of health conditions between persons living in Briarwood and the comparison area, or other reasons. On average, Briarwood participants had lived in their homes for somewhat less time (mean 9.0 years) than participants from the comparison area (mean 11.7 years), and conditions with first onset since moving to the current home may be underestimated. Some of these findings (ulcers, chronic bronchitis, urinary tract disease, tremors or shakes) were based on very few cases of illness and might be more susceptible to chance variations. Most of the elevated health conditions were not statistically significant.

No pattern of organ dysfunction was noted for the medical tests in Briarwood.

Forestdale

Participants from Forestdale reported similar numbers of symptoms and illnesses as did participants from the comparison area. No patterns of excess health problems were

noted, although Forestdale participants reported more cases of arthritis than did comparison area participants.

No pattern of organ damage or dysfunction was noted in Forestdale.

Picture Lakes

Participants from Picture Lakes reported two illnesses, with first onset since participants moved to their homes, more often than did comparison area participants (high blood pressure and ulcers or other stomach disease) and both of these conditions were statistically significant. Five current illnesses were reported more often by Picture Lakes participants than comparison area participants and four were statistically significant (Seizures or epilepsy [not statistically significant], heart disease, chronic bronchitis, ulcers or other stomach disease, and arthritis or other joint disease). Picture Lakes participants reported half as much asthma as in the comparison area.

Possible factors related to these findings might include a larger number of preexisting health conditions, a greater awareness of health problems by Picture Lakes residents than by comparison area residents, an unknown exposure source, or some other reason. The finding for seizures or epilepsy was based on only 3 reported cases.

No pattern of organ damage or dysfunction was noted in Picture Lakes.

Overall Findings

Higher numbers of reported cases of chronic bronchitis, ulcers or other stomach disease, and arthritis were reported in the communities surrounding the MMR.

RECOMMENDATIONS

Higher numbers of reported cases of chronic bronchitis, ulcers or other stomach disease, and arthritis were reported in the communities surrounding the MMR. Additional followup activities may be recommended for study participants reporting these conditions in order to evaluate the reports; determine their specific nature, severity, and duration; and to assist participants in evaluating their health effects.

The study findings will be discussed with the participating communities to identify and consider community based recommendations based upon the findings of this study.

ABSTRACT

Introduction: Otis Air National Guard Base (OANGB)/Camp Edwards is part of the 22,000-acre Massachusetts Military Reservation (MMR) located on upper Cape Cod where on-base groundwater contamination has resulted in contamination of private residential and public wells near the base. Contaminants found included fuel-related compounds, volatile organic compounds (VOCs), and lead. Concerns expressed by communities within the vicinity of the MMR included possible health effects resulting from these contaminants in the groundwater and surface water and emissions from past artillery propellant powder bag burning activities. This study was designed to assess the health status of residents living near the MMR compared with that of residents living in a nonexposed comparison community.

Methods: Residents were selected for the study in a two-stage process. In April and May 1993, a complete door-to-door census was taken of four communities most affected by the site and a similar unexposed comparison community. Ashumet Valley in Falmouth and Briarwood in Mashpee were the two communities affected by contaminated groundwater plumes and potentially airborne contaminants. Forestdale in Sandwich and Picture Lakes in Bourne were included due to community concern about potential exposure to airborne contaminants. A random sample of full-time residents ages 8 through 75 years was selected from the census in each community and invited to participate. Participants were required to have lived in their homes for 8 years, the time when contaminated groundwater was

discovered and residents began to use municipal water. When the total number of eligible residents meeting the 8 year residency requirements were exhausted, the residency requirement was reduced to 1 year minimum until the desired sample size of 100 was met for each target area. A total of 605 people participated in May and June 1993. At the request of the community, an additional 303 persons were added to the study in October 1994 from Forestdale, Picture Lakes and the comparison area with the purpose of increasing sample size and statistical power to examine health effects in the individual target areas. Given the smaller population sizes in Ashumet Valley (367) and Briarwood (235), the approximate 50% participation rate, the expected attrition between data collection years, and uneven age distributions, additional participants were not sought for Briarwood and Ashumet Valley because a balanced sample of 100 additional people could not be obtained. A total of 908 people answered questions from a standardized questionnaire and provided blood and urine specimens during the two years of data collection. The questionnaire collected information on self-reported illnesses and symptoms and female reproductive history. The study also measured blood lead levels and conducted medical tests which examined the liver, kidney, and immune systems.

Results: Blood lead levels were similar among the five communities and similar to the national average. Female reproductive histories were similar between the different communities. A higher proportion of participants in Ashumet Valley and Briarwood, the two communities with contaminated groundwater, reported having had more health conditions

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

with first onset since moving to their homes than participants in the comparison area. However, fewer differences were found in the prevalence of current (as of the date of interview) self-reported health conditions. Participants from Forestdale were found to have similar reports of symptoms and illnesses as the comparison area. Participants from Picture Lakes were found to have more self-reported current health conditions than participants from the comparison area, but few with first onset since moving to their homes. Few differences were noted between the target and comparison areas in measures of organ system dysfunction. No pattern of particular health effects that might indicate exposure to specific toxicants was identified and odds ratios were generally low (<2.0 , indicating less than a two-fold difference in reported health conditions between communities) and not statistically significant.

Conclusions: The results of this study indicated that persons living in areas with contaminated groundwater water might have had more health problems in the past compared to persons in the comparison area. However, at the time of the interviews prevalence of reported health conditions were generally similar as in the comparison area, with a few exceptions. A higher prevalence of ulcers or other stomach disease, chronic bronchitis, and arthritis or other joint disease was reported in most of the target areas.

This study had several limitations, including the fact that many tests were examined and some findings might have been due to chance alone, many calculations were based upon

small numbers of reported illnesses and might not have been reliable, symptoms and illnesses were self-reported and not verified by medical records or examination, participants from the target areas might have recalled health events to a different degree than participants from the comparison area, individual exposure data were not available to verify exposure or examine a dose-response, and the population size in the group most likely to have been exposed was small.

Recommendations: The findings of higher prevalences of chronic bronchitis, arthritis, and ulcers or other stomach disease may warrant additional followup activities.

INTRODUCTION

Otis Air National Guard Base (OANGB)/Camp Edwards is part of the 22,000-acre Massachusetts Military Reservation (MMR) located on Upper Cape Cod. It is situated within the towns of Bourne, Mashpee, and Sandwich, and is adjacent to the town of Falmouth (Figure 1). In November 1989, the U.S. Environmental Protection Agency (EPA) placed the entire reservation on the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) National Priorities List (NPL) for hazardous waste clean up. Further information on site history, contamination levels, community concerns, and potential health implications from exposure to site-related substances is available in the study protocol and the public health assessment for OANGB (2); a summary follows.

Extensive groundwater contamination occurred on the military base as a result of aircraft and vehicular operations and maintenance, past disposal practices, hazardous waste storage, and fuel management. The most significant potential for release of solvents and petroleum occurred during periods of elevated military activity from 1940 through 1970. The Cape Cod aquifer, the sole aquifer in the area, underlies the MMR and groundwater flows outward from the reservation toward the surrounding communities resulting in contamination of private residential and public wells near the base. In the 1980s, testing of groundwater found fuel-related compounds, volatile organic compounds (VOCs), and lead. The off-site communities affected by the contaminated plumes with completed exposure

pathways were the Briarwood subdivision in Mashpee and the Ashumet Valley neighborhood in Falmouth (2).

Trichloroethylene (TCE), lead, 1,1-dichloroethylene (DCE), and 1,2-dichloroethane (1,2-DCA) were first detected in residential wells in 1986 in Briarwood. In 1988, bottled drinking water was provided to 46 residents with contaminated wells and in 1990 the neighborhood was provided an option to connect to the public water supply. However, as of January 1996, 11 homes were known to still be on private wells (personal communication, January 1996, Mashpee Board of Health).

In Ashumet Valley, the principal contaminants of concern were TCE, tetrachloroethylene (PCE), 1,1-DCA, and chloroform, which were detected in private wells in 1985 and 1990. An estimated 100 persons were exposed to the contaminated groundwater. Residences in Ashumet Valley were placed on the municipal water supply beginning in 1987 (personal communication, Falmouth Water District). Residents of both Ashumet Valley and Briarwood have also expressed concern about the possibility of exposure to airborne contaminants from the MMR, however, no air monitoring data were available to address this issue.

Two communities with potential for contamination through groundwater and air were the Forestdale neighborhood of Sandwich and the Picture Lakes area of Bourne, although at

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

the time of the study, contaminated groundwater plumes had not reached these study areas and no air monitoring data were available to measure air contaminant levels.

Until the summer of 1992, artillery propellant powder bags were being burned during military exercises at the training range located in the center of the reservation. While bag burning was occurring, ambient air was not monitored.

The communities within the vicinity of the MMR expressed concern about possible health effects resulting from contamination in the well water, groundwater, surface water from on-site storm drains, fire training areas, chemical spill locations, past artillery propellant powder bag burning activities on site, and overall safety of the facility.

In response to community concerns about apparent elevations in cancer rates (in particular, lung cancer and leukemia), Boston University conducted a comprehensive case-control study of cancer involving residents of the Upper Cape Cod area in 1990 (3,4). The investigators concluded that there was an association between the elevation in cancer rates and "some environmental factors"; however, the magnitude of this relationship could not be quantified (4). Brain cancer was associated with proximity to the MMR's runways and airports, Upper Cape Cod public water supplies, and ever having lived within a half-mile of cranberry bogs. It was suggested that further investigation of brain cancer in the five-town area of Barnstable, Bourne, Falmouth, Mashpee, and Sandwich was warranted (4).

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

The Massachusetts Department of Public Health is following up on this recommendation with an updated review of cancer incidence by census tract in the Upper Cape Cod region (5).

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted the study described in this report to evaluate the health of the residents living in the vicinity of the MMR who were potentially exposed to contaminants from the MMR.

PURPOSE

The study was designed to determine whether the people likely to have been exposed to contaminants from the MMR had a higher occurrence of (1) self-reported symptoms and illnesses or (2) organ damage or dysfunction as indicated by abnormal values of selected biomedical tests, than did residents of a nonexposed community.

Study Objectives

The objectives of the study were:

1. To determine well water consumption and usage by local residents living within the selected communities surrounding the MMR (the target areas).
2. To compare the prevalence of self-reported symptoms and self-reported physician-diagnosed illnesses of individuals living within the target areas to the prevalence of the same symptoms and physician-diagnosed illnesses in the comparison area.

3. To evaluate and compare the distribution of biomedical test results of organ-system functions for the kidney, liver, and immune systems in the target areas with biomedical test results from the comparison area.
4. To characterize the distribution of blood lead levels of residents in the target areas and compare it with the distribution of blood lead levels of residents in the comparison area.

Rationale for Study Design

ATSDR conducted a health study in response to community concerns and consistent with the public health assessment's recommendation to evaluate residential well water consumption and the health status of people residing in proximity to the MMR (2). The residents of the communities surrounding the reservation were concerned about general health problems within their communities. A cross-sectional symptom and illness prevalence study was designed to evaluate the possible association between residence near the MMR and adverse health effects. Through interviews with a standardized questionnaire, information was collected on each participant's symptom and illness history, female reproductive history (if applicable), demographics, occupational history, and tobacco and alcohol use. Blood and

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

urine specimens were collected to measure organ system dysfunction and evidence of exposure to lead.

METHODS

Summary of Study Methods

The study was conducted in two phases. The first phase was a door-to-door census with a residential well water survey conducted in April and May 1993. The census identified persons residing in the study areas and how long they had lived in their homes. The residential well water survey characterized well water use. The second phase consisted of a standardized symptom and illness prevalence questionnaire and collection of blood and urine specimens. Participation in both phases of the study was voluntary and informed consent was given prior to participation.

Blood and urine specimens were collected and tested to assess the function of the kidney, liver, and immune systems. Blood lead levels were also measured. The laboratories (a local hospital laboratory, a national clinical reference laboratory, and laboratories at the National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, Georgia) followed specific testing protocols and quality assurance and quality control procedures.

Selection of the Target Population

The target population consisted of the current (as of May 1993) residents of four communities located adjacent to the MMR: the Briarwood subdivision in Mashpee, the Ashumet Valley neighborhood of Falmouth, the Forestdale neighborhood of Sandwich, and the Picture Lakes region of Bourne (Figures 1 through 5). The Briarwood and Ashumet Valley communities were chosen because those areas had completed water exposure pathways from contaminated groundwater plumes emanating from the base and underlying the neighborhoods. There was also community concern about potential airborne contaminants from base activities. The Forestdale and Picture Lakes communities were included because of community concern regarding potential exposure from migrating groundwater plumes and potential exposure to airborne contaminants from base activities. For purposes of this report, Forestdale and Picture Lakes will be referred to as the "air-only" pathway areas. Briarwood and Ashumet Valley will be referred to as "water/air" pathway areas.

Selection of a Comparison Population

Two 1990 U.S. Census block groups from the town of Brewster (Figure 6) were selected as the comparison community on the basis of the following criteria: (1) sociodemographic characteristics (race, sex, age, average income, and education distribution)

were similar to the target population; (2) Brewster is located on the Cape but not within a 5-mile radius of the MMR; and (3) the areas were not located near any recognized sources of exposure to a chemical industry that might expose residents to hazardous substances. The comparison area is also similar geographically to the target areas, being generally forested, near a large undeveloped area (Nickerson State Park) and near a pond. The target areas include ponds and all adjoin the MMR which has large undeveloped areas.

Sample Size and Power Estimates

Sample size estimates were based upon conditions related to VOC exposure, given that VOCs were the primary contaminants of concern among residents of the target areas. Exposure to VOCs such as TCE and DCE can cause upper airway irritation and bronchoconstriction (6). In 1990, the National Center for Health Statistics reported prevalence rates of 9% for acute respiratory illnesses or symptoms, 5% for chronic bronchitis, and 5% for asthma (7). Therefore, a predetermined proportion of 6% for respiratory symptoms and illnesses was chosen as the background prevalence for the sample size calculations.

Sample size calculations were based upon a cross-sectional study design with a 2 to 1 ratio for the target and comparison groups, assuming a background illness prevalence in the

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

comparison area of 6%, an alpha level of significance of 0.10, a beta level of 0.20 (80% power), and 2.25-fold difference in rate comparisons (odds ratio = 2.25). Given these parameters, a sample size of approximately 200 was needed in the comparison area and 400 in the combined target area.

At the request of the community, the study was later expanded to include additional participants with the purpose of increasing the sample size and statistical power for assessing health effects within the individual target communities. Using the same methods and procedures as in the original data collection effort, in October 1994 an additional 100 participants were sought from each of the Forestdale, Picture Lakes, and comparison areas. Additional participants were not sought from Ashumet Valley or Briarwood because there were not enough eligible residents (full time residents from 8 through 75 years of age, who had not participated in the 1993 data collection phase of the study).

Eligibility Criteria

Eligible study participants included those residents who were full time residents (not weekend or seasonal) and had lived in the target or comparison areas continuously for the previous 8 years, the approximate time when groundwater contamination was detected in Briarwood and Ashumet Valley and the time when many residents discontinued use of private

wells. However, in instances when there were not enough residents who had lived in their homes for at least 8 years to obtain the needed sample size in each sampling strata (see Sampling Algorithm Section), the residency requirement was relaxed to a 1 year minimum in order to obtain the needed sample size. The list of eligible residents meeting the 8 year residency requirement was exhausted prior to relaxing the residency requirement to 1 year. Eligible participants were also restricted to persons 8 through 75 years of age. The original 8-year residency requirement determined the lower age limit for study participants (8 years of age). However, as a service to the community, young children in the target area were offered free blood lead screening.

Sampling Algorithm

The results of the door-to-door census were used to determine eligibility and to randomly select residents from each area to provide a comparable sample in the target and comparison areas. In each of the 5 (four target areas and one comparison area) study areas, a random sample was selected from each of eight age and sex categories (males and females aged 8 through 14 years, 15 through 35 years, 36 through 60 years, and 61 through 75 years) (Table 1). The number of participants selected from each age and sex category was based on the proportion of that category in the combined target population at the time of the census. A total of 100 residents were sought from each of the 4 target areas using this stratified sampling technique. A total of 200 residents were sought in the comparison area.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

For instance, 8% of the total (census) target population was male from 8 through 14 years of age, so 8 males aged 8 through 14 years were sought in each of the four target areas and 16 (8% of 200) were sought in the comparison area.

For the October 1994 data collection phase of the study, an additional 100 residents were sought in each of the Forestdale, Picture Lakes, and comparison areas. Participants were required to meet the same eligibility requirements as those participating in the 1993 study. The same stratified sampling technique was used for the two time frames. Additional participants were not sought from Ashumet Valley or Briarwood because there were not enough eligible residents (full time residents from 8 through 75 years of age, who had not participated in the 1993 data collection phase of the study) to fill all the age- and sex-strata. This decision was based upon the small number of eligible people living in the two areas (367 in Ashumet Valley and 235 in Briarwood), the large number of residents who had already declined to participate in 1993, the approximate 50% participation rate observed during the first data collection effort, anticipated attrition of about 10%, and the need to maintain an age- and sex-balanced group of participants.

Data Collection

Reimbursement for Participation

In order to improve participation rates in both target and comparison areas, participants were reimbursed \$25.00. Participation in the study required approximately one and a half hours to complete which included travel to the study site (approximately 15 minutes), questionnaire administration (approximately 60 minutes), and laboratory tests (approximately 15 minutes). The reimbursement amount was considered to be adequate compensation for each participant's time, but not coercive for those residents who did not want to participate.

Interview

A questionnaire was administered to all participants which included questions on sociodemographic characteristics, a detailed self-reported history of symptoms and illnesses, a female reproductive history (if applicable), tobacco and alcohol usage, characteristics of the household environment, and subjective questions on environmental concerns. The questions on illness history were phrased, "Has a physician or other medical provider ever told you that you had: [illness]"; however, self-reports were not verified by comparison with medical records. Questions concerning symptoms were phrased, "Have you ever had [symptom]." The symptom and illness questions were followed up with questions concerning the date of

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

first onset and the date of the last episode. All interviewers participated in a 3-day training program that included instruction in the proper administration of the questionnaire.

Collection of Biologic Specimens

Blood and urine specimens were collected for a battery of biomedical tests designed to assess lead exposure, as well as measure liver, kidney, and immune system functions. Blood specimens were collected by trained phlebotomists. Blood specimens were used to perform a complete blood count, serum chemistry panel, lymphocyte phenotyping, and serum immunoglobulin determination. Spot urine specimens collected at the time of appointment (ie, these were not first morning void specimens) were used to perform the urinalysis and measurement of urinary albumin, retinol binding protein, urine N-acetyl-beta-D-glucosaminidase (NAG), and urine alanine aminopeptidase (AAP). These tests are part of the basic screening tests suggested by the Centers for Disease Control and Prevention and ATSDR Subcommittee on Biomarkers of Organ Damage and Dysfunction to evaluate the renal, hepatobiliary, and immune systems (8). The biomedical tests used in this study are listed in Figure 7.

Blood lead levels were assessed in the 1993 portion of the study; however, the finding of low blood lead levels precluded the need for further blood lead testing in the 1994 data

collection phase of the study. Blood lead analyses were conducted by the National Center for Environmental Health, Division of Environmental Health Laboratory Services using the Zeeman graphite furnace atomic absorption method (9). Standard quality control and assurance procedures were used.

Complete blood counts (using a Celldyne 3000 instrument) and urinalyses (using a clinitek 200 Ames 9SG; dipstick and microscopic exam) were performed by Cape Cod Hospital, Hyannis, Massachusetts. The serum chemistry panel was performed by MetPath laboratories, Wood Dale, Illinois, using a Hitachi 736 spectrophotometer. Quality control and assurance measures included doing 10% replicates and 15% controls. Relative standard deviation for controls and relative percent differences for replicates were all found to be within acceptable laboratory standards.

The specialized immune tests (lymphocyte phenotyping) and renal (kidney) function tests (urine albumin, retinol binding protein, NAG, and AAP) were performed by laboratories of the National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, Georgia. Quality assurance and quality control for the immune panel included doing 10% blind splits which were found to agree with the originals within an average of 2%. Immunoglobulins were determined at the Foundation for Blood Research, Scarborough, Maine.

Participants' Notification of Test Results

After results were received from the laboratories, the study team reviewed them to interpret the findings and recommend specific actions, when appropriate. The results and any recommendations were sent in writing to the adult participants or to the parents or guardians of the child participants. In cases in which a test revealed a finding of immediate significance to a person's health, that person or that person's parent or guardian was notified by telephone and in writing as soon as the results became available.

Data Analysis

Statistical analyses were supported using release 6.08 of the Statistical Analysis System (SAS) on the Centers for Disease Control and Prevention mainframe computer (IBM 3090-200E). The analyses proceeded from simple, descriptive statistics to stratified analyses and multivariate linear and logistic regression analyses.

Blood lead levels were found to be more normally distributed when they were transformed using the natural logarithm, so all blood lead analyses were done using the log-transformed values. The mean (average) blood lead concentrations were then exponentiated to provide geometric means with the units of micrograms per deciliter ($\mu\text{g}/\text{dL}$).

Student's t-tests were used to compare the mean (average) values of continuous variables (age, blood lead, years living in the current home, medical test values, and the like) between groups. A test was considered statistically significant if the p value was <0.10 . Multivariable linear regression models were used to compare blood lead levels and medical test values between target and comparison area residents while controlling for other factors (age, sex, alcohol, and cigarette use). Chi-square tests were used to measure the association between area of residence (target and comparison areas) and categorical outcomes (demographic characteristics, frequency of reproductive outcomes, health behaviors, and health outcomes). The odds ratio (OR) and Mantel-Haenszel 90% confidence interval (CI) were used to measure the association between area of residence and health outcomes. An OR of 1.0 indicated the same occurrence of illness in the target as in the comparison area. An OR greater than 1.0 indicated a higher occurrence in the target area, while an OR less than 1.0 indicated a lower occurrence in the target area than in the comparison area. Crude ORs for area of residence (target versus comparison) were calculated for each symptom and illness queried when at least two cases were observed in each study area. When one or fewer cases of disease were reported in an area, the numbers were considered to be too small to produce reliable statistics and, therefore, the OR and 90% CI were not calculated. The occurrence of symptoms and illnesses were measured in two ways: (1) currently having the condition at the time of interview (referred to as "current" health conditions for the remainder of the report) and (2) having first onset of the condition since the participant moved to his or her residence. The first measure was done to assess current symptom and

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

illness burden in the target areas relative to the comparison area. The second measure ensured that conditions existing before the exposure occurred would not obscure possible exposure-induced illness. These two definitions are not mutually exclusive. Stratified analysis and logistic regression were used for all symptoms and illnesses with sufficient sample size (generally at least 10 cases in each study area) and biologic plausibility. Results from the logistic regression models were presented when they differed from the crude results. Confounding was operationally defined as an adjusted OR differing by 10% or more from the crude OR. Given that many illnesses and symptoms were reported infrequently (causing small sample size problems) and there were no *a priori* reasons to suspect interaction, interaction was not assessed and only main effects were examined.

Logistic regression was used in the multivariate analysis of symptoms and illnesses to adjust for effects of other risk factors and potential confounders. These analyses were carried out separately for those currently having the condition and those with first onset since moving to their home. Two dummy variables were created for the water/air and air-only pathway areas with the referent group being the comparison area participants. The covariates used in all models were factors associated with symptoms and illnesses: age, sex, income, smoking history, and alcohol use. When the outcome of interest was first onset of a condition since moving to the current home, the number of years a participant had lived in his or her home was also included as a potential confounder (unrelated to exposure). This was done because, independent of potential exposure, the longer a person had lived in his or

her home, the greater chance that person had of having developed a health condition since moving to that home. Models examining current health effects did not control for length of residency. Year of study was examined as a cofactor in the two communities with potential air-only pathways, but not in the two with water/air pathways since no additional data were collected in these two areas in 1994. When symptoms and illnesses in the 4 target areas were assessed individually, models were run separately for each area. However, models were run only if the number of cases was determined to be sufficient, usually at least 8 to 10 cases in each of the target and comparison areas. A backward elimination regression approach was used to determine the model that best fit the data. A variable was retained in the model if it confounded the exposure-illness association, if the p value for the variable was ≤ 0.10 , or if the variable improved the fit of the model. When the results of the logistic regression models were the same as the crude results (less than 10% difference), the crude results are reported. When the results differed by more than 10%, the results of the logistic regression models are reported.

The occurrences of symptoms and illnesses were analyzed combining all ages, unless: (1) the illness had differing etiologies for children and adults or (2) no children had the specific illness. A crude analysis was done to look at symptoms and illnesses among children 8 through 14 years of age. The small number of children and few cases of illness prevented analysis beyond the crude stage. The following conditions were not analyzed for this age group: high blood pressure; hepatitis, yellow jaundice, or other liver disease;

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

kidney disease; urinary tract disease, including prostate trouble; diabetes; ulcer or other stomach disease; emphysema; rheumatic fever or rheumatic heart disease; heart attack, heart disease, or other heart problems; stroke; gallstones or other gallbladder disease; and chest pain. All other analyses combined these children with participants aged 15 through 75 years. Because of the small sample sizes available for analyses of children, exact methods were used to calculate significance levels and confidence intervals (using the mid-p adjustment) when the large sample methods indicated statistical significance. The large sample methods used in this study underestimate the significance levels compared to exact methods which produce larger p-values and wider confidence intervals.

Because data were collected during two time periods, May and June 1993 and October 1994, results from the two years of data were compared to determine whether they could be combined for analysis. ORs were calculated to compare the occurrence of symptoms and illnesses among the 200 comparison area participants from the 1993 data collection with the occurrence among the 100 comparison area participants from the 1994 data collection effort. Odds ratios were also calculated for each of 21 medical tests comparing the number of participants with a medical test result inside versus outside the reference range for the two years of data collection in the comparison area. The distributions of the test results for the two years were also compared using the Kolmogorov-Smirnov test, as well as visual examination of plots.

The target areas were examined in two ways: 1) Each of the four target areas compared to the comparison area separately; 2) The two communities with well water and potential air pathways (Ashumet Valley and Briarwood) combined (the water/air pathway areas) and compared to the comparison and the two communities with potential air-only pathways (Forestdale and Picture Lakes, the "air-only" areas) combined and compared to the comparison area. The four target areas were not combined into an overall "target area" because of the unequal sample sizes from the different target areas, their different exposure potentials, and different years of data collection.

The effects of recall bias (differential recall of health conditions by persons in the target and comparison areas) were examined using techniques similar to Ozonoff (10). The effect of participant concern about environmental or chemical hazards on reporting of symptoms and illnesses was assessed for each of the 26 symptoms and illnesses for which there was sufficient sample size. When sample sizes were sufficient, the data were stratified by participant concern about environmental or chemical hazards in their neighborhoods and interaction and confounding were assessed. To assess interaction, the stratum specific ORs were compared qualitatively and quantitatively using the Breslow-Day test for homogeneity of the ORs. If interaction was not present, confounding was assessed comparing the crude and Mantel-Haenszel adjusted ORs. Generally, if the stratum specific ORs are similar for those concerned about environmental hazards in their neighborhoods to those who reported they were not concerned, it is unlikely that concern about environmental hazards biased the

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

reporting of health conditions. However, if the ORs among those reporting concern were higher than those not reporting concern, no conclusions could be made regarding the existence of reporting bias. Reporting bias due to knowledge of exposure (separate from concern about exposure) could not be assessed given the widespread knowledge of contamination.

Laboratory Test Analysis

The results of the panel of laboratory tests were examined in several ways. First, the distributions of laboratory test results in the comparison area were examined for 1993 and compared with those of 1994 to determine whether any changes had occurred. Kolmogorov-Smirnov tests were used to compare the distributions statistically. Plots of the distributions were also visually examined. When data were determined to be similar, the two years were combined. If not similar, the data were not combined. The distributions of the data were examined for extreme outliers which were then removed from analyses of means. Persons with known health conditions that would affect the results of the medical tests were removed from analyses of those tests. Persons with diabetes, kidney disease, or gout ($n = 36$) were removed from analyses of the kidney. Persons with cirrhosis of the liver, hepatitis, or jaundice ($n = 5$) were removed from analysis of the liver. Analyses were repeated including

the extreme outliers and those with kidney and liver diseases to determine the effect of dropping these observations on the results.

The laboratory test result distributions were examined for normality. Non-normally distributed data were transformed using the natural logarithm. However, when the results of transformed data were the same as those of the untransformed data, it was decided that untransformed results would be presented to provide clearer presentation of results. Further, given the generally large sample sizes for the continuous data, the central limit theorem states that means of non-normally distributed data will tend to be normally distributed and, therefore, statistical tests of these means are valid. The data were examined by comparing mean (average) values between the target and comparison areas (with the comparison area as the referent group) using student t-tests; linear regression models were also used to simultaneously control for the effects of age, sex, current smoking, and current alcohol consumption. Analyses for Ashumet Valley and Briarwood used only the first-year data from the comparison area since data were only collected in these two target areas in the first year and differences were observed in some laboratory tests between the two years of data collection. Analyses for Forestdale and Picture Lakes used the combined results from the comparison area as the reference. Models for Forestdale and Picture Lakes also included a term for year of study.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

The data were also examined to determine the prevalence of values outside laboratory reference ranges. When available, standard age- and sex-specific laboratory reference ranges were applied to the data. For the specialized tests in the kidney and immune panels, standard reference ranges were not available. For the four specialized kidney tests (NAG, AAP, RBP, and albumin) reference ranges (upper 95 percentiles derived from 10 age and sex categories) were computed from the database of 1400 healthy participants (from non-exposed comparison areas only) from this and 7 previous ATSDR studies (11,12,13,14,15) and unpublished studies in North Carolina and Nebraska) which performed the same tests at the same laboratories. Similarly, reference ranges (5 to 95 percentiles) for the specialized immune test results were also obtained from the combined results of previous ATSDR studies (10-14,16,17). Being above or below the reference range does not necessarily indicate an abnormality, but was used for analysis purposes. ORs and 90% CIs were calculated for those inside or outside of the reference ranges in the target areas compared with those in the comparison area. Where sample size was sufficient (at least 10 cases outside the reference range for the target and comparison areas) logistic regression models were used to simultaneously control for the effects of age, sex, cigarette smoking, and alcohol consumption (and year of study for Forestdale and Picture Lakes). A term was also included for current use of analgesics (for example, aspirin, acetaminophen, and ibuprofen) for models examining liver and kidney tests. Separate models were run for each target area. The investigators focused on test results which were statistically significant or which had twice as many outside the reference range as in the comparison area. The

pattern of test results were also examined. For instance, if kidney disease were a problem in an area, one would expect several of the kidney tests to be outside of the reference range. If a single test were outside the reference range, it was considered more likely to represent normal variation.

Community Involvement and Notification

Local officials and citizens were involved throughout the development and implementation of all phases of the study. The Division of Health Studies, ATSDR, established a community assistance panel (CAP) that included citizens living around the MMR. The purpose of this panel was to facilitate communication between local officials, residents of the community, and ATSDR staff.

RESULTS

Census

During the census, 1,133 residences (75% of 1,501 total residences identified) were contacted in the target areas and 1,637 (84% of 1,950 total residences identified) were contacted in the comparison area. Of those residences contacted, approximately 61% were nonpermanent residences in the comparison area and 24% were nonpermanent residences in the target areas. Permanent residency was defined as the principal residence of the household for at least 9 months of the year. It was anticipated that a large percentage of households would be nonpermanent given the tourist, weekend, and vacation uses of Cape Cod. While there was a difference in the number of permanent residents living in the study areas, only permanent residents were eligible for participation in the study.

Participation Rates

Participation rates in the health study were similar in the target and comparison areas. Of those residents randomly selected from those contacted in the 1993 census, 56% of target area residents participated in the health study and 51% of comparison area residents participated in the health study. In the 1994 health study data collection effort, 61% of

contacted residents participated in the target areas while 53% of contacted residents participated from the comparison area.

Prior to the second data collection effort in 1994, letters were mailed out to prospective participants informing them of the upcoming study. Out of the 300 letters mailed in each of the study areas, 4 were returned in Forestdale, 49 in Picture Lakes, and 24 in the Comparison area, indicating that between 1 and 16% of residents identified in the 1993 census had moved and were no longer eligible.

Persons participating in the study had similar age, sex, and racial distributions as the eligible populations from which they were drawn (Table 2). These distributions were also similar across the 5 study areas. As expected, study participants had lived in their homes longer than the general population given the emphasis on selecting those with the greatest potential for exposure to contaminated drinking water (at least 8 years of residency).

The information in Table 2 also illustrates the reason that an additional 100 people were not sought in the communities of Briarwood and Ashumet Valley in 1994. Given participation rates of 50%, the expected attrition between 1993 and 1994, and the fewer numbers of middle-aged people, achieving a balanced sample of 100 people in each in these two areas was not possible. Further, most all residents who had used well water were included in the original 1993 study.

Demographic Characteristics of Target and Comparison Area Participants

Target and comparison area participants had similar demographic characteristics except for length of residency and income (Table 3). Participants from the Briarwood community had lived in their homes for less time than the other communities, with 69% having lived in their homes for less than 10 years compared with 46% in the comparison area and 24% to 53% in the other target areas. The mean residency in Briarwood was 9.0 years compared with 11.7 years in the comparison area, 11.1 years in Forestdale, 13.4 years in Ashumet Valley, and 13.4 years in Picture Lakes. Eligibility was restricted to persons living in their homes for 8 or more years, except when there were insufficient numbers of persons living in a study area to meet that requirement. In the small community of Briarwood, this was a particular problem and was evident when assessing years living in the home. Length of time living in the current home became a particularly important factor to control for in analyses when the outcome of interest was having had the first onset of symptoms and illnesses since moving to the current home. Differing amounts of time living in the current home translated to different amounts of time "at-risk." However, differences in residency time could not be controlled for the symptoms and illnesses which were reported too infrequently to allow analysis beyond the crude stage. The mean ages of participants in the five areas were similar with 37.6 years in Ashumet Valley, 39.4 in Briarwood, 39.5 in Forestdale, 40.4 in Picture Lakes, and 39.7 in the comparison area.

Participants in the second year of data collection were somewhat older (mean 41.7 years of age in 1994 and 38.4 years of age in 1993, $p = 0.02$) and had lived in their current homes for a somewhat shorter period of time (mean 12.3 years in 1993 and 10.9 years in 1994, $p = 0.001$). The shorter residency was expected given that the 1993 sample included many of the longer term residents, leaving fewer of these available for the 1994 effort.

Well Water Consumption

A large majority (more than 88%) of participants from the two communities with contaminated groundwater plumes (Ashumet Valley and Briarwood) indicated that their households had once used well water as the primary source of drinking, cooking, and bathing water (Table 4). On average, it had been 1.7 years since Briarwood participants had used well water for domestic purposes and 5.7 years since Ashumet Valley participants had used well water for domestic purposes. Participants reported using well water for an average of 8 years in both communities. At the time of interview, one participant in Ashumet Valley and 26 participants in Briarwood indicated they had used private well water for domestic uses within the past 60 days (Table 5). In the two communities with potential future groundwater contamination, 52% of Forestdale participants and 5% of Picture Lakes participants indicated their households had ever used well water as the primary source of water in their homes. From 3 to 11% of households in Picture Lakes and Forestdale reported using well water within the previous 60 days. While well water consumption was not a pathway of exposure

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

at the time of the study for participants in Forestdale and Picture Lakes, it remains a potential exposure pathway, particularly if the groundwater plumes continue to migrate towards these communities.

Blood Lead Levels

Blood lead levels were similar between the four target areas and the comparison area (Table 6), and were similar to national averages (18). No biologically significant differences in blood lead levels were found when target area participants were compared to comparison area participants by age groups (8 through 14 and 15 through 75 years). As anticipated, males had higher mean blood lead levels than females, and older people had higher blood lead levels than younger people. Mean blood lead levels among children aged 8 through 14 ranged from 1.4 in Ashumet Valley to 2.0 in Briarwood. The highest blood lead level among a child aged 8 through 14 years was 7.3 $\mu\text{g}/\text{dL}$.

Of the 15 children under 8 years of age who were not part of the study but whose parents requested a blood lead test, the range in blood lead levels was 1.0 to 2.7 $\mu\text{g}/\text{dL}$ with a mean of 2.0 $\mu\text{g}/\text{dL}$ and a standard deviation of 0.50 $\mu\text{g}/\text{dL}$. These levels were well below 10 $\mu\text{g}/\text{dL}$, the Centers for Disease Control and Prevention action level (19).

Symptoms and Illnesses

Comparison of Symptom and Illness Results from 1993 to 1994

To determine whether the two years of data would be combined, results from the 1993 data collection effort were compared with those from the 1994 effort. In 1993, 204 persons from the comparison area participated with a mean age of 37.9 years (range 8 to 74 years). In 1994, 103 persons from the comparison area participated with a mean age of 43.1 years (range 9 to 75 years). From Forestdale and Picture Lakes, the mean age in 1993 was 38.9 (range 8 to 75 years) while it was 40.9 in 1994 (range 9 to 76 years).

ORs were calculated for each queried symptom and illness comparing the two years of data collection for the comparison area separately from the target areas (Table 7). No pattern of increased or decreased ORs was noted, indicating that participants in 1994 did not show an overall pattern of increased or decreased reporting of health conditions compared with those participating in 1993. Many of the ORs were based on a small number of observed cases in each year. A generally similar number of ORs were above 1.0 as less than 1.0. Therefore, the two years of data were combined for analyses of symptoms and illnesses, and year of study was included as a confounder in logistic regression models.

Three conditions (hepatitis, yellow jaundice, or other liver disease; rheumatic fever or rheumatic heart disease; and stroke) were reported infrequently and the results are not presented in tables. Only two cases of hepatitis, yellow jaundice or other liver disease were reported with first onset since moving to the current home among Forestdale participants, 3 were reported among comparison area participants, and none were reported among participants in the other study communities. Two cases of stroke with first occurrence since moving to the current home were reported in each of Forestdale, Picture Lakes and the Comparison areas, one case in Briarwood, and none in Ashumet Valley. Only one case of rheumatism or rheumatic heart disease was reported with first onset since moving to the current home in the comparison area and no cases were reported in the other four communities. Sparsity of data prevented further analyses of these outcomes.

Illnesses and Symptoms among Combined Water/Air Pathway Areas versus Comparison Area

Onset Since Moving to Home. Of 21 illnesses with first onset since the participant moved to his/her current home and for which ORs could be calculated, 15 had ORs which were >1.0 , indicating higher occurrence in the water/air pathway target areas (Ashumet Valley combined with Briarwood participants) (Table 8). Five of the conditions had ORs which were ≥ 2.0 (tremors or shakes, hayfever, pneumonia, ulcers or other stomach disease, and thyroid disease), indicating an occurrence in the water/air pathway areas at least twice as

high as in the comparison area and two were statistically significant at $p < 0.1$ (hayfever and pneumonia). One condition, neurologic problems, was reported half as often ($OR = 0.5$) as in the comparison area.

Of 14 symptoms, 12 had ORs which were > 1.0 (Table 9). Four of symptoms had ORs which were ≥ 2.0 and each was statistically significant at $p < 0.1$ (frequent periods of drowsiness or fatigue; irritation or burning in your nose; watery, burning, or irritated eyes; and bleeding gums).

Current Symptom or Illness. ORs could be calculated for 17 illnesses (defined as the participant still having the condition at the time of interview) (Table 10). Of these 17 illnesses, 12 were reported more often in the target area. Of the 12 conditions with ORs > 1.0 , 2 conditions had ORs which were > 2.0 and 3 conditions had statistically significant ORs (chronic bronchitis, $OR = 3.2$, 90% confidence interval = $[1.4-7.1]$, ulcers or other stomach disease, $OR = 2.6$ $[1.0-6.4]$, and arthritis, rheumatism, or other joint disease, $OR = 1.9$ $[1.3-2.8]$). Diabetes, on the other hand, was reported less often than in the comparison area, $OR = 0.3$ $(0.1-1.0)$.

Of 13 symptoms, 9 had ORs which were > 1.0 (Table 11). One symptoms had an OR which was ≥ 2.0 (frequent periods of drowsiness or fatigue, $OR = 2.0$ $[1.3-3.2]$, but

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

two more were statistically significant (trouble sleeping, OR = 1.6 [1.0-2.5], $p < 0.1$, and watery, burning, or irritated eyes, OR = 1.8 [1.2-2.6]).

No confounding was found for any of the symptoms and illnesses when assessed in logistic regression models and, therefore, the crude results apply. In general, symptoms were reported more often than illnesses; however, both tended to be reported more often in participants from the water/air pathway areas than in the comparison area.

Combined Air-Only Pathway Versus Comparison Area

First Onset of Symptom or Illness Since Participant Moved to Home. Of 24 illnesses with first onset since the participants moved to their current homes and for which ORs could be calculated, 12 had ORs which were > 1.0 and 12 had ORs which were < 1.0 , indicating that illnesses in general were not reported more often in the air-only pathway areas (participants from Forestdale and Picture Lakes combined) than in the comparison area (Table 8). One illness had an OR > 2.0 (ulcers or other stomach disease, OR = 2.8 ([1.1-6.9]) while another illness had an OR < 0.5 (cancers of the blood, OR = 0.4 [0.1-1.5]).

Of 14 symptoms with onset since the participants moved to their current homes, 12 had ORs which were >1.0 (Table 9). Two of these symptoms were statistically significant (frequent periods of drowsiness or fatigue, $OR = 1.7 [1.1-2.5]$ and bleeding gums, $OR = 2.2 [1.3-3.7]$).

Current Symptom or Illness. Of 20 illnesses, participants in the air-only pathway had a higher prevalence of 11 illnesses than participants in the comparison area, one of which had a statistically significant OR (arthritis, rheumatism or other joint disease, $OR = 1.7 [1.2-2.4]$) (Table 10). While none of these conditions were reported even twice as much (all conditions had ORs which were < 2.0), two conditions (tremors or shakes and cancers of the blood) were reported half as much as in the comparison area.

All 13 symptoms were reported more often by air-only area participants than by comparison area participants, with 3 being statistically significant (frequent periods of drowsiness or fatigue, $OR = 1.8 [1.2-2.6]$; bleeding gums, $OR = 1.9 [1.1-3.4]$; and chest pain, $OR = 1.8 [1.0-3.1]$) (Table 11). None of the conditions had ORs which were >2.0 .

Confounding was not found for any of the symptoms or illnesses, and the crude results apply. Participants in the air-only pathway areas reported rates of illnesses similar to

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

those in the comparison area, yet reported more symptoms than those in the comparison area.

Analysis of Occupations of Study Participants

Job-Related Chemical Exposures

The occupations of adult participants were examined in order to determine whether there might be a number of people with job-related chemical exposures which might confound the illness associations. Of 708 adults over 18 years of age, 519 (73%) were employed at the time the interview was given. Study participants reported a wide range of occupations in many different industries. Job titles and industries were coded using the U.S. Census codes (20) (Tables 12 and 13). These codes were then reviewed and those that were considered to have potential chemical exposures were grouped together. Chemical-related occupations and industries were not common (Table 14). A similar percentage of study participants from each of the 5 study areas reported working in potentially chemically related occupations or industries (10.7% in Forestdale to 13.9% in Ashumet Valley and Briarwood) (chi-square $p = 0.855$). The absolute numbers of people reporting such jobs were small ranging from 10 in Ashumet Valley to 26 in the comparison area. When the types of jobs participants had held for most of their lives were also examined, a similar

number reported jobs considered to be potentially chemical related. Given the similarity between the target and comparison areas in the proportion of participants reporting chemical related jobs and the small absolute number of these people, no further stratification was necessary and it was determined that occupation was unlikely to account for any findings in the analysis of symptoms and illnesses. Further, while the jobs were classified as to whether they were potentially chemical related, without indepth, detailed assessment of occupations and industries, the coding as "chemical" related was likely to miss some people with chemical exposure and to include others who did not have chemical exposure.

MMR-Related Jobs

Another concern was the potential for including in the study people who worked on the MMR (and thereby might have had additional chemical exposures) which might obscure or erroneously show associations between area of residence and health conditions. The questionnaire identified 18 participants who indicated that they had jobs on the MMR, jobs associated with the MMR or the military, or jobs that were defense- related (Table 14). There were two each in Ashumet Valley and Briarwood, 6 in Forestdale, 8 in Picture Lakes, and none in the comparison area. The mean age of these people was 52.1 years (range 31 to 70 years). The mean age of adults not working on the MMR was similar (50.1 years, range 31 to 76, $p = 0.50$). Six of the 18 with MMR-related jobs were women. When the 18

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

participants were removed and the crude analysis for symptoms and illnesses repeated, the calculated ORs remained the same, indicating that the inclusion of residents who also currently or recently worked on the MMR or in the military did not confound the results, and therefore, the results which included these persons were valid.

Power and Sample Size

The study was designed to be able to detect an OR of 2.25 with 80% power and a significance level of 0.1 given a background illness prevalence of 6% or more in the comparison area. Prior to conducting the study, the actual illness prevalences that would be found were unknown. The results of the study showed that 8 of the 26 illnesses and 9 of the 16 symptoms with first onset since moving to the home reached or surpassed the 6% level in the comparison area. Among children, four illnesses and no symptoms met the 6% level in the comparison area. Regarding current conditions, 6 of 26 illnesses and 8 of 14 symptoms had a 6% or higher prevalence in the comparison area. Among children, three illnesses and two symptoms had a 6% or higher prevalence in the comparison area.

It was not anticipated that all symptoms and illnesses would meet the 6% background design criteria, particularly for rare illnesses. The rarest outcomes that were reported among comparison area participants were currently having loss of consciousness/blackouts and cancer (only 1 each in 307 comparison area participants had these conditions). A sample

size of more than 10,000 participants (greater than the number available in the study communities) would have been required to achieve the same design criteria for such rare conditions.

In addition, because of the interest in the community for pathway-specific analyses and analyses of the four individual target communities, as well as the unbalanced design that resulted when 3 of the 5 study areas had additional participants added in 1994, an analysis combining all target areas was not done. Therefore, original power calculations that indicated 400 participants would be needed in the combined target area and 200 in the comparison area were not met, except for analyses of the combined air-only pathway areas. The sample sizes in the final study were sufficient for detecting an OR of 2.25, with $\alpha = 0.10$ and power = 80%, when the background prevalence of a condition was at least 12 to 14% for comparisons of the individual water/air pathway areas to the comparison area; 7% to 9% for comparisons of the individual air-only pathway areas or combined water/air pathway areas; and 5% for comparisons of the combined air-only pathway areas. However, the investigators did not rely upon statistical significance alone when interpreting the findings, but also examined the magnitude of the observed ORs.

Subjective Analysis

The questionnaire collected subjective information to assess potential reporting bias for symptoms and illnesses. No difference was found between target and comparison area participants in how they rated their own health or in whether they had a health problem that they thought was caused by chemicals at their workplaces. However, 7% of target area participants (range 4% to 11% in the different target areas) compared with 1% of comparison area participants felt they had a health problem caused by chemicals in or near their homes. When asked, "Are you worried or concerned about environmental or chemical hazards in your neighborhood?", the majority of target area participants compared with 30% of comparison area participants answered "yes" (Table 15). Within the target area communities, 61% of Picture Lakes participants, 77% of Forestdale participants, 80% of Ashumet Valley participants, and 84% of Briarwood participants answered "yes." When participants were asked "Is there any other situation that you think is endangering your health?" a similar number of participants responded "yes" in the 5 study areas (22% in the comparison area and 23% to 29% in the 4 target areas).

To examine the potential effect of concern about environmental hazards on reporting of health, the symptom and illness data were stratified on participants' concern about environmental or chemical hazards. When occurrences of symptoms and illnesses were measured as the first onset since moving to the current home (Table 16), ORs tended to be

higher among those reporting concern about environmental hazards than among those not reporting this concern (13 versus 8 for the water/air pathway areas and 15 versus 6 in the air-only pathway areas). In three cases concern about environmental hazards was a statistically significant effect modifier (defined as the Breslow-Day test for homogeneity of the OR having a p value < 0.10), indicating that for most conditions, the OR calculated among those reporting concern and those not reporting concern was not statistically significantly different. In many cases, the stratification produced small numbers which affected both the stability of the individual ORs calculated and the statistical significance of the ORs and the Breslow-Day test. Adjusted ORs were calculated when the Breslow-Day test was not statistically significant. The adjusted ORs were different from the crude in only a few cases, indicating little confounding. In two cases, the ORs were higher in the unconcerned stratum than in the concerned stratum (asthma and eczema). Among comparison area participants, asthma was not associated with concern about the environment. However, 11% of comparison area participants who were concerned about the environment reported having had arthritis compared to 7% who reported they were not concerned about the environment.

When the occurrence of symptoms and diseases was defined as currently having the condition (Table 17), ORs tended to be similar or somewhat lower among those reporting concern about environmental hazards than those not reporting concern (9 higher in those concerned versus 8 higher in those not concerned in the water/air pathway area and 8 higher

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

in those concerned versus 13 higher in those not concerned in the air-only pathway area).

Adjusting for the effect of concern led to somewhat different ORs in 20 of 42 instances.

When the ORs for reported health conditions among those reporting no concern about environmental hazards were examined in particular, it was found that symptoms and illnesses were reported approximately equally between the water/air pathway target area and comparison areas (approximately equal number of conditions had ORs which were > 1.0 as were < 1.0) regardless of the definitions of symptoms or illnesses. When ORs were calculated for participants in the air-only pathway versus comparison area, 28 conditions had ORs which were > 1.0 versus 16 conditions with ORs < 1.0 .

Given the lack of statistically significant differences in ORs calculated for those reporting concern and those not reporting concern, the lack of a strong pattern of higher OR among those reporting concern, and the general lack of change in the OR when adjusting for concern, it appears that reports of concern about environmental hazards are not a major effect modifier or confounder in the analysis of current health conditions, although such concerns could not be ruled out. When the outcome assessed was first onset of condition since the participants moved to their current homes, the results were mixed and the potential for reporting biases due to environmental concern could not be ruled out.

Symptoms and Illnesses Among Children 8 Through 14 Years of Age

Symptoms and illnesses that affect children were examined for the 137 participating children aged 8 through 14 years. Of 16 illnesses and 13 symptoms queried, sufficient numbers were available to calculate ORs for 5 illnesses and 8 symptoms. Illnesses with first onset since moving to the current home were reported equally among children in the target and comparison areas (Table 18). Symptoms were equally reported among children in the air-only target areas as in the comparison area; however symptoms were reported slightly more often among children in the water/air pathway target areas than those in the comparison area (4 symptoms reported more often in the water/air area compared to 2 symptoms reported more often in the comparison area) (Table 19). One symptom was statistically significantly higher in the water/air area (watery, burning or irritated eyes, OR = 4.8 [1.7-13.5], 11 cases were reported in the water/air target area compared to 5 in the comparison area).

When current illnesses and symptoms were assessed for children living in the water/air areas (Tables 20 and 21), all three illnesses for which ORs could be calculated had ORs which were > 1.0 (Asthma, OR = 1.1; Hayfever or other respiratory allergy, OR = 2.0; Eczema or other skin problems, OR = 3.0). Illnesses were reported equally in the air-only pathway area and the comparison area. Symptoms were reported more often in both the water/air pathway and air-only pathway areas than in the comparison area, although

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

the numbers of symptoms with sufficient cases were small with 5 symptoms in the water/air pathway areas and 7 in the air-only pathway areas out of a total of 13. Watery, burning, or irritated eyes were reported more commonly in the water/air pathway area than in the comparison area (OR = 3.6 [1.4-9.5], 11 cases versus 6). In the air-only areas, the OR was 0.5 (0.2-1.4), indicating half as many participants reported eye symptoms as in the comparison area.

None of the symptoms or illnesses were reported often enough to allow an assessment of confounding. Most observed numbers of reported cases of symptoms and illnesses were small and ORs were likely to be unstable given the small numbers.

Analysis of Symptoms and Illnesses in Each Individual Target Area

The reports of symptoms and illnesses were next assessed for each of the four target areas individually (Tables 22-25). As was done with the previous analyses, confounding was assessed using a logistic model only when there was sufficient sample size, at least 8-10 cases of illness in each area. Otherwise, crude results were examined. Twenty four self-reported, physician-diagnosed illnesses and 14 symptoms were assessed for each area. The level of statistical significance was set at 0.1, indicating that one could expect on average 1 in 10 findings could be found to be statistically significant due to chance alone. In addition

to examining statistical significance, the numbers of conditions reported more often in the target area than the comparison area ($OR > 1.0$) were examined as well as those reported at least twice as often in the target area ($OR \geq 2.0$). Conversely, the authors also examined conditions reported half as much or less than in the comparison area ($OR \leq 0.5$). Given the large number of conditions assessed and the large number of statistical tests performed, the magnitude of observed differences as well as statistical significance were used when examining the importance of findings.

Reported Health Conditions in Picture Lakes

In the community of Picture Lakes, illnesses with first onset after moving to the current home were reported somewhat more often than in the comparison area (13 illnesses had ORs which were > 1.0 versus 9 illnesses which had $ORs \leq 1.0$). Two illnesses were statistically significantly elevated: high blood pressure, $OR = 1.9$ (1.2-2.9) and ulcers or other stomach disease, $OR = 4.1$ (1.6-10.2). Only ulcers or other stomach disease were reported more than twice as often in Picture Lakes as in the comparison area.

Symptoms with first onset since moving to the current home were generally reported more often in Picture Lakes than the comparison area, with 11 of the 14 symptoms having ORs which were > 1.0 . Three symptoms were statistically significant: frequent periods of

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

drowsiness or fatigue, OR = 1.8 (1.1-2.9); watery, burning, or irritated eyes, OR = 1.6 (1.1-2.6); and bleeding gums, OR = 2.5 (1.4-4.5). Poor coordination, although not statistically significant, was reported more than twice as often by Picture Lakes participants (OR = 2.1 [0.9-5.1]).

Of 20 current illnesses, participants in Picture Lakes had elevated ORs for 12. Four of these illnesses were statistically significant: heart attack, heart disease, or other heart problems, OR = 2.2 (1.3-3.7); chronic bronchitis, OR = 2.4 (1.0-5.6), $p < 0.10$; ulcers or other stomach disease, OR = 2.6 (1.0-6.4), $p < 0.10$; and arthritis, OR = 1.8 (1.2-2.7). Asthma was reported statistically significantly less often in Picture Lakes (OR = 0.5 [0.3-1.0]), $p < 0.10$. While based on only 3 cases and not statistically significant, seizures or epilepsy was reported more than twice as often in Picture Lakes (OR = 2.3 [0.5-10.3]). When the analysis was restricted to people ages 40 years and older, the age group most at risk for chronic bronchitis, four cases of chronic bronchitis were observed and the OR was reduced to 1.2 (0.2-5.6).

Eleven of thirteen current symptoms were reported more often in Picture Lakes than in the comparison area. Two of these symptoms were statistically significant and had ORs which were > 2.0 : (frequent periods of drowsiness or fatigue, OR = 2.1 [1.3-3.2] and chest pain, OR = 2.4 [1.3-4.4]).

Several of the elevated conditions were cardiovascular (high blood pressure, heart disease, and chest pain). Ulcers or other stomach disease and frequent periods of drowsiness or fatigue were the two reported conditions which were statistically significantly elevated or had an OR > 2.0 using both definitions of first onset since moving to the home and currently having the condition.

Summary of Health Condition Results in Picture Lakes

Participants from Picture Lakes reported an expected (relative to the comparison area) number of illnesses with first onset since participants moved to their homes, but more than expected numbers of current illnesses (heart disease, chronic bronchitis, ulcers or other stomach disease, and arthritis or other joint disease).

Reported Health Conditions in Forestdale

Forestdale participants reported currently having 11 of 13 symptoms more than did comparison area participants. Two symptoms were reported more than twice as much in Forestdale, one of which was statistically significant (bleeding gums, OR = 2.1 [1.1-4.0] and frequent periods of nausea or vomiting, OR = 2.3 [0.8-6.6]). When symptoms were examined for first onset occurring after the participants moved to their current homes, 12 of

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

14 were higher in Forestdale. One symptom was statistically significant (frequent periods of drowsiness or fatigue, OR = 1.7 [1.1-2.7]) and no symptoms had an OR which was ≥ 2.0 .

Of 17 current illnesses examined with sufficient numbers, 7 were reported to occur more often in Forestdale participants than comparison area participants. One illness was statistically significantly elevated in Forestdale (arthritis, OR = 1.6 [1.1-2.5]) and one condition had an OR of at least 2.0 (neurologic or nervous system problems, OR = 2.0 [0.9-4.3]). One condition was reported half as much in Forestdale as in the comparison area (urinary tract disease, OR = 0.5 [0.1-1.9]).

When illnesses were examined for those with first onset after moving to the home, the distribution of illnesses was almost evenly split with 11 being reported more often in Forestdale and 10 being reported more often in the comparison area. One illness was reported less than half as often as in the comparison area (diabetes, OR = 0.5 [0.2-1.3]) and no conditions were reported with an OR which was ≥ 2.0 . Arthritis or other joint disease was the only conditions reported statistically significantly more often in Forestdale than in the comparison area (OR=1.7 [1.0-2.8], $p < 0.1$).

Summary of Forestdale Results

While symptoms were reported more often in Forestdale, illnesses were reported with approximately equal frequency as in the comparison community. No particular pattern of

symptoms or illness were noted and it appeared that the health of participants in Forestdale was similar to that of participants in the comparison area.

Briarwood

Participants from Briarwood reported currently having more illnesses than participants in the comparison area (11 of 15 illnesses [with sufficient numbers for analysis] were reported more often in Briarwood than in the comparison area, ORs > 1.0). One of these ORs was statistically significant (arthritis, OR = 1.8 [1.1-2.9]), and four had ORs greater than 2.0 (weakness or paralysis, OR = 2.1 [0.9-4.6]; chronic bronchitis, OR = 2.1 [0.7-6.1], based on 4 cases in Briarwood; ulcers or other stomach disease, OR = 2.6 [0.9-7.7], based on 4 cases in Briarwood; and urinary tract disease, OR = 2.2 [0.8-6.2], based on 4 cases in Briarwood). When the analysis was restricted to people ages 40 years and older, the age group most at risk for chronic bronchitis, two cases of chronic bronchitis were observed and the OR was reduced to 1.4 (0.1-9.2).

Briarwood participants reported illnesses with first onset since moving to the current home more often than participants from the comparison area (for 11 of 16 illnesses with numbers sufficient for analysis). Four of these illnesses were reported more than twice as often among Briarwood participants and one was statistically significant (tremors or shakes,

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

OR = 3.2 [0.9-11.6], based on three cases in Briarwood and 3 cases in the comparison area); hayfever or other respiratory allergy, OR = 2.1 [0.9-4.6]; pneumonia, OR = 2.0 [1.0-3.7], $p < 0.10$; and ulcers or other stomach disease, OR = 2.4 [0.7-8.3], based on three cases in Briarwood and 4 cases in the comparison area).

Nine of twelve current symptoms were reported more often in Briarwood than in the comparison area with two being statistically significant (frequent periods of drowsiness or fatigue, OR = 2.4 [1.4-4.0] and watery, burning, or irritated eyes, OR = 1.8 [1.1-3.0]). Eleven of fourteen symptoms with first onset since moving to the home were reported more often in Briarwood, five of which were statistically significant and four of which were at least 2.0 (numbness or the sensation of pins and needles, OR = 2.2 [1.2-3.7]; frequent periods of drowsiness or fatigue, OR = 2.0 [1.1-3.4]; dizziness, OR = 1.9 [1.1-3.2]; irritation or burning in your nose, OR = 3.8 [1.7-8.6]; and watery, burning or irritated eyes, OR = 2.6 [1.6-4.3]).

Summary of Reported Health Conditions in Briarwood

Participants from Briarwood reported somewhat more than expected (relative to the comparison area) numbers of illnesses with first onset since participants moved to their homes and current health conditions. Ulcers or other stomach disease, drowsiness, and

irritated eyes were reported elevated for both definitions (current and first onset since moved to home). Respiratory illnesses tended to be elevated in Briarwood.

Reported Health Conditions in Ashumet Valley

Both illnesses and symptoms were reported more often in Ashumet Valley than in the comparison area. Fourteen of sixteen current illnesses had ORs > 1.0 , with two being statistically significant and four being ≥ 2.0 (chronic bronchitis, OR = 4.3 [1.8-9.9]; bowel disease or intestinal problems, OR = 2.0 [0.9-4.4]; ulcers or other stomach disease, OR = 2.5 [0.8-7.5]; arthritis, OR = 2.0 [1.2-3.3]). When the analysis was restricted to people ages 40 years and older, the age group most at risk for chronic bronchitis, four cases of chronic bronchitis were observed, but the OR remained elevated at 3.0 (0.6-13.4). Among those self-reported illnesses with first onset since moving to their current homes, 15 of 19 had ORs which were > 1.0 , 11 were ≥ 2.0 and 6 were statistically significant (frequent periods of anxiety, nervousness, or depression, OR = 2.2 [1.3-3.8]; heart disease, OR = 2.0 [1.0-7.0]; chronic bronchitis, OR = 2.6 [1.0-7.0]; hayfever or other respiratory allergy, OR = 2.2 (1.2-4.1); pneumonia, OR = 2.4 [1.3-4.4]; ulcers or other stomach disease, OR = 2.3 [0.7-8.1], based on 3 cases in Ashumet Valley; bowel disease or intestinal problems, OR = 2.2 [1.0-4.9]; urinary tract disease, OR = 2.3 (1.2-4.4); thyroid disease, OR = 3.1 [1.1-8.5]; anemia or other blood disorders, OR = 2.1 [1.1-4.2]; cancer of the

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

blood, OR = 2.3 [0.7-7.9], based on 3 cases in Ashumet Valley; and arthritis, OR = 1.8 [1.0-3.2]).

Nine of twelve current symptoms were reported more often in Ashumet Valley than the comparison area with 3 being statistically significant (severe or frequent headaches OR = 2.2 (1.3-3.5); trouble sleeping OR = 1.8 (1.1-3.0); and watery, burning, or irritated eyes OR = 1.7 (1.1-2.8). For self-reported symptoms with first onset since moving to the current home, 11 of 14 were reported more often in Ashumet Valley with four being statistically significant (frequent periods of drowsiness or fatigue 2.0 (1.2-3.4); watery, burning, or irritated eyes OR = 3.1 (1.9-5.0); bleeding gums OR = 2.7 (1.4-5.3) and chest pain OR = 1.8 (1.1-3.1).

The data were stratified by concern about environmental hazards in the neighborhood for those conditions with sufficient sample size and crude ORs > 1.0. Of 10 illnesses meeting these criteria, 6 had larger ORs in the concerned group than in the unconcerned group; 3 had larger ORs in the unconcerned group than the concerned group; and one condition was reported equally between the concerned and unconcerned groups. Among the 7 symptoms assessed, one OR was greater in the concerned group than unconcerned group, four were greater in the unconcerned group, and two were equal.

Summary of Reported Health Conditions in Ashumet Valley

Overall, few symptoms and illnesses were currently elevated in Ashumet Valley, however many more participants in Ashumet Valley than in the comparison area reported first onset of symptoms and illnesses since moving to their current homes. Chronic bronchitis, ulcers, arthritis, watery eyes, and bleeding gums were elevated no matter whether the definition used was currently having the condition or having first onset since moving to the current home. Respiratory conditions were elevated in Ashumet Valley (bronchitis, hayfever, and pneumonia). Neurological conditions were not elevated.

Summary of Findings of the Individual Target Areas. The study focused on conditions with ORs that were statistically significant or that were at least 2.0 or greater (Tables 26 and 27). Many elevated ORs were based on small numbers and, therefore, the focus on reported conditions with ORs which were ≥ 2.0 or statistically significant findings might still include results that are unstable. Conversely, some nonstatistically significant associations with ORs which were < 2.0 , yet which could be biologically meaningful, might have been overlooked. Some conditions were elevated in all four target areas, an unexpected finding given the different routes of possible exposure. Chronic bronchitis and ulcers or other stomach disease were elevated in three of four target areas (Ashumet Valley, Briarwood, Picture Lakes). Arthritis was elevated in all four target areas. When the data were restricted to ages 40 years and older, the age group most at risk of chronic bronchitis,

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

reported chronic bronchitis remained elevated in Ashumet Valley, but not in Briarwood or Picture Lakes. Frequent periods of drowsiness or fatigue were also reported more often in all four target areas than in the comparison area. Watery, burning, or irritated eyes were reported more often in three of the four target areas (Ashumet Valley, Briarwood, Picture Lakes) and bleeding gums were reported more often in three of four target areas (Ashumet Valley, Forestdale, Picture Lakes).

In general, it appeared that only Ashumet Valley participants had a large number of illnesses with first onset since they moved to their current homes. These illnesses covered a wide range of illnesses and organ systems. Briarwood participants also had some conditions reported more than those in the comparison area.

Elevated prevalences of current illnesses appeared primarily in participants from Picture Lakes, and, to a lesser degree, participants from Briarwood and Ashumet Valley.

Symptoms in the target areas were reported more often than illnesses, and participants from Ashumet Valley, Briarwood, and Picture Lakes all reported more symptoms with first onset since moving to the current home than participants from the comparison area. Fewer current symptoms were reported in each target area than symptoms with first onset since moving to the current home.

Reported Symptoms and Illnesses Among Well Water Users in the Water/Air Pathway Areas

An analysis was also conducted to examine the effects of persons from the Ashumet Valley and Briarwood areas who reported that their households had ever used well water as the primary source for drinking, cooking, or bathing water (Tables 28 through 31). Because some participants never used well water in these communities, this analysis focused only on those who had used well water and, therefore, had more potential for exposure to contaminated groundwater. The same analyses of symptoms and illnesses were conducted; however, participants in the Ashumet Valley and Briarwood areas were restricted to those who reported ever using well water. Insufficient numbers of participants never using well water ($n = 26$) in these areas prevented a comparison of those ever using well water and those never using well water.

Removing participants from the analyses who reported never using well water had little effect on the results. Similar ORs were calculated for the entire target area as those restricted to just well water users. ORs that were statistically significant for the larger sample tended to remain statistically significant among those restricted to the well water user group. ORs tended to increase slightly, although the number ≥ 2.0 went down slightly. Some statistical characteristics changed when persons never using well water were removed. Developing heart disease since moving to the current home in Ashumet Valley became

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

statistically significant; chest pain and anemia became statistically significant for the combined well water group. Conversely, bowel disease became nonsignificant in Ashumet Valley, and ulcers or other stomach disease and hayfever became nonsignificant in Briarwood. Current bronchitis became nonsignificant in Briarwood. Current drowsiness or fatigue became significant in Ashumet Valley.

Reproductive Outcomes

The self-reported reproductive histories of female study participants aged 15 years or older were analyzed (Table 32). There was little difference between the study areas in the percentages of women who had ever been pregnant (74% in Ashumet Valley, 78% in Briarwood, 83% in Forestdale, 80% in Picture Lakes, and 84% in the comparison area). Women who had ever been pregnant had similar numbers of pregnancies and live births. Dates for live births were not collected and, therefore, birth rates could not be calculated for the time since participants moved to their current homes. Similar numbers of adverse pregnancy outcomes (still births, children born with birth defects, and miscarriages) were reported in the five study areas. The sparsity of data did not allow the analysis to examine differences in the number of years a woman had lived in her home, number of pregnancies since moving to the current home, maternal age, or other important factors which could have affected the observed numbers of reported adverse outcomes.

Laboratory Test Results

The results of the laboratory tests were assessed by comparing mean values in the target areas to those in the comparison area (Tables 33 and 34) and by comparing the percentage of participants with test results above or below a given reference range in the target areas to the comparison area (Tables 35 through 37). Results which were statistically significant, or which indicated a two-fold difference in the numbers outside the reference range are summarized in Table 38. The results of the laboratory tests are presented below by organ system and then by community.

Comparison of 1993 and 1994 laboratory data

The two years of data were compared using comparison area participants and examining the two years of data using means, graphical plots, and comparing the proportion of participants outside of standard reference ranges. When the results for the two years of data collection were compared, it was found that significant differences in the distributions existed between the two years for serum total protein, serum albumin, serum globulin, and urine retinol-binding protein (RBP). While the same laboratory protocol was followed during the two data collection periods, two differences occurred. Blood serum specimens had been stored frozen in the 1993 data collection effort while they were stored refrigerated in the

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

1994 data collection effort which was a possible, although unlikely, explanation for the differences observed. Due to laboratory capacity changes, different laboratories were used for the 1993 and 1994 urine RBP determinations which may explain some of the differences observed in RBP results. Because of the differences, and concern about the possibility of differences in seasons and differential exposure to infectious agents between the May and June 1993 and October 1994 data collection phases, it was decided that it would be inappropriate to use the expanded comparison group for comparisons with results from Ashumet Valley and Briarwood, which had only 1993 data. The two years of data were combined for comparisons between the remaining two target areas (Forestdale and Picture Lakes) and comparison area. When adjustment for potential confounders was possible (sufficient sample size), a term for year of study was included for analyses of these three areas.

Results of Tests by Organ System

Hematologic (Blood) Tests

Hemoglobin and hematocrit values were examined as measures of the oxygen-carrying capacity of the blood system (Tables 33-38). Low hemoglobin or hematocrit levels (age- and sex-specific reference ranges were used to classify levels) were measured with the same or greater frequency in the comparison area participants as in participants from Ashumet Valley,

Brairwood, and Picture Lakes indicating that these target area participants were the same or better off in these markers as participants in the comparison area (Tables 35-36). Forestdale participants had more people with low hemoglobin levels compared to the comparison area, but the same number with low hematocrit levels. No differences were found in mean hemoglobin or hematocrit values (Tables 33-34). These results confirm the lack of any elevated reporting of anemia in three of the target areas, but do not confirm the self-reports of elevated anemia in Ashumet Valley.

Kidney Tests

Laboratory test results were examined (1) including all study participants and (2) excluding participants with conditions known to affect the kidney (diabetes, kidney disease, gout; n = 24 (4%) in target area, 12 (4%) in comparison area). Little difference was seen in the results regardless of whether persons were excluded; therefore, results which included all study participants are presented in the tables. Standardized reference ranges for the urinary proteins and enzymes AAP, NAG, albumin, and RBP were not available and, therefore, reference ranges for these tests were calculated based on the 95th percentile of data obtained in prior ATSDR studies. Being above the reference range did not necessarily indicate an abnormality, but was used for statistical purposes only. Standard reference

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

ranges supplied by the laboratory conducting the tests were available for serum creatinine, blood urea nitrogen (BUN), and serum proteins.

Comparisons between the target and comparison communities for the four urine tests that are considered to be most sensitive to preclinical kidney damage (urinary AAP, albumin, RBP, and NAG) yielded generally low and nonsignificant ORs for all four target areas. The only exception to this was urine albumin, which was elevated in twice as many participants in the Briarwood and Picture Lakes areas as in the comparison areas (Tables 35 and 36, summarized in Table 38). Serum creatinine and BUN were examined as indicators of kidney function, although these are relatively insensitive tests. ORs comparing the four target areas with the comparison area for elevated serum creatinine and BUN were generally low and nonsignificant. Although twice as many participants in the Ashumet Valley target area had elevated serum creatinine as did those in the comparison area, this was not a statistically significant finding and other more sensitive kidney markers were not elevated.

Few differences were observed when mean values of the four kidney tests for the target areas were compared with the comparison area (Tables 33 and 34, summarized in Table 38).

The crude measures of serum BUN, serum creatinine, serum total protein, serum albumin, and serum globulin yielded mixed results with one statistically significant finding of

a higher proportion of participants with elevated serum albumin in the water/air areas than in the comparison area. No difference in mean serum albumin was observed.

Immune System Tests

Standardized reference ranges for the immune tests were generally not available and therefore reference ranges for the immune tests were calculated based on the 5th to 95th percentile of results obtained from a database of 1400 participants from prior ATSDR studies. Being above or below the reference range did not necessarily indicate an abnormality.

White Blood Cell and Lymphocyte Phenotype Results

More comparison area participants had white blood cell counts, the percentages of lymphocytes, and the percentage of eosinophils outside the reference ranges than did target area participants (Tables 35 and 36, summarized in Table 38). Specialized lymphocyte phenotyping characterized the lymphocytes as being B cells (producers of immunoglobulins [antibodies]) and T cells (with subtypes CD4 and CD8). A higher proportion of participants in the Briarwood target area had a percentage of T cells above the reference range than did

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

participants in the comparison area. This result was corroborated with Briarwood area participants having a higher mean percentage of T cells than the comparison area (71.7 versus 69.7, $p = 0.035$) (Table 33). Briarwood participants also had a higher proportion of B cells as compared to the comparison area, although not statistically significant. Participants in Briarwood were found to have a higher total lymphocyte count, mean percentage of T cells, CD4 count, and CD4/8 ratio than comparison area participants. Immune deficiency is typically indicated by lower values for these tests. In the Forestdale area, a greater percentage of participants had a low percentage of T cells than did participants in the comparison area, but were similar in mean percentage of T cells, B cells, CD4 count, and CD4/8 ratio. Indicators of immune deficiency, such as a low CD4 count and a low CD4/CD8 ratio, were nearly absent in all study areas.

Immunoglobulin Test Results

Levels of serum immunoglobulins (IgA, IgG, and IgM) were also assessed. Ashumet Valley had twice as many participants with an IgA level above the laboratory reference range than the comparison area, and had higher mean IgA levels than the comparison area (222 milligrams per deciliter [mg/dL] versus 199 mg/dL, $p = 0.024$) (Tables 33 and 35). IgG and IgM were similar in Ashumet Valley and the comparison area participants. Immunoglobulin levels among Briarwood participants were similar among comparison area participants. Forestdale had a higher proportion of participants with elevated IgA levels than comparison area participants (Table 36). Forestdale participants and also had a higher mean

IgA levels than comparison area participants (231 mg/dL versus 205, $p = 0.002$), but IgG and IgM levels were similar among comparison area participants (Table 34). Picture Lakes participants had a higher mean IgA level than comparison area participants, yet had more participants with IgA levels less than the 5th percentile than the comparison area. None of the other immunoglobulin levels were different for Picture Lakes and the comparison area.

Atypical Lymphocyte Phenotype Patterns

An additional finding was that the CDC laboratory identified six participants (one in 1993 and five in 1994) with lymphocyte phenotype patterns similar to those seen in lymphoproliferative disorders (a high percentage of B cells). This finding was noted in at least one participant from each of three target areas (Briarwood, Forestdale, Picture Lakes) and the comparison area. One of these six was previously diagnosed as having chronic lymphocytic leukemia. The white blood cell counts and lymphocyte counts for the remaining five participants were not indicative of leukemia or lymphoma. These participants were notified of their laboratory findings, offered repeat confirmatory testing, and referred to their physicians for followup. Specialized confirmatory testing provided by a laboratory of the U.S. Food and Drug Administration became an option in 1994 and these people were offered further testing. The interpretation of these laboratory test findings is unknown and it is unknown whether these findings indicate a future health problem. Similar laboratory test

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

findings have been observed in 5 other studies conducted by ATSDR from 1991 through 1994 in other areas of the United States. Efforts are underway to determine the clinical relevance these laboratory findings.

Liver Test Results

The results of the liver tests were examined two ways: (1) including all study participants and (2) excluding persons with conditions known to affect the liver enzymes (cirrhosis of the liver, hepatitis, or other liver disease; $n = 5$) and for serum albumin (cirrhosis of the liver, hepatitis, or other liver disease; $n = 5$; and kidney disease, diabetes, and gout; $n = 36$). Since excluding these persons from the analysis had little effect on the results, the results presented include all study participants.

Three liver enzymes (GGT, AST, and ALT) were used to assess liver function. Liver enzymes were defined as being elevated if two of the three were above the reference ranges. This definition was used to rule out clinically unimportant laboratory abnormalities. Liver enzyme results were similar between the target and comparison areas. The presence of low serum albumin can also suggest liver impairment, yet no study participant in any of the study areas had a serum albumin level below the reference range.

Laboratory Test Results by Community

The study compared the average (mean) medical test values for each of the communities to the comparison community and the number of people with test results above or below the usual range in each community (Table 38).

Ashumet Valley Test Results

Participants from Ashumet Valley had somewhat higher average levels of white blood cells, antibody G, antibody A, and % B cells (Table 38). They were twice as likely to have an antibody A level and serum creatinine level above the reference ranges, but less than half as likely to have a B cell percentage above the reference range or a white blood cell count below the reference range. No pattern of organ damage or dysfunction was noted.

Briarwood Test Results

Briarwood participants were more likely to have creatinine-adjusted urine albumin levels and T cell percentages above the reference ranges, but were half as likely to have white blood cell counts and creatinine-adjusted urine RBP outside the reference ranges compared to participants from the comparison area (Table 38). Briarwood participants also had somewhat higher average levels of white blood cells, antibody A, total lymphocyte

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

counts, and ALT (a liver enzyme) than comparison area participants. No pattern of organ dysfunction was noted for the medical tests.

Forestdale Test Results

Forestdale participants were more likely to have a serum level of antibody A above the reference range than the comparison area. They were more likely to have a T cell percentage and hemoglobin level below the reference range than comparison area participants. Although there were some differences in test results, no pattern of organ damage or dysfunction was noted.

Picture Lakes Test Results

Picture Lakes participants were twice as likely to have a urine albumin level and T cell percentage outside the reference range, but were half as likely to have a white blood cell count, hematocrit, BUN, or serum antibody G level outside the reference range. No pattern of organ damage or dysfunction was noted.

Summary of Laboratory Test Results

Few statistically significant results were found when examining ORs that compared the number of participants above or below a reference range or when comparing mean test

values in the target area with the comparison area. Few differences of a two-fold magnitude were observed. Patterns indicative of organ system damage, such as multiple test results of the same organ being outside the reference range, were not observed.

Agreement Between Self-Reported Health Conditions and Related Medical Tests

Some of the queried symptoms and illnesses had effects which had the possibility of being measured using the medical tests performed during the study. Associations which seemed biologically plausible were examined with the medical test as the dependent variable and the health condition as the independent variable of interest for. Age, sex, alcohol and cigarette smoking were included as covariates in the models. Several conditions which are potentially immune system related (cancer of the blood; hayfever; arthritis; watery, burning, or irritated eyes; and burning in the nose) were examined for their relationship to markers of the immune system (total lymphocyte count, eosinophil count, IgA, IgG, and IgM). Of the 25 associations examined, 6 were statistically significant. Persons reporting hayfever had a higher eosinophil count than did those not reporting hayfever. Persons reporting watery, burning, or irritated eyes had higher mean levels of IgM and IgG. Persons with arthritis had lower total lymphocyte counts, a finding of unknown biologic significance. Persons reporting a cancer of the blood had higher lymphocyte counts. However, most of the statistical models were very poor at explaining the medical test results with adjusted R^2

values <0.14 , that is, the variables of interest could explain less than 14% of the variation in the data. The best models achieved were those for anemia. Persons reporting anemia had statistically significantly lower hematocrit and hemoglobin levels and the models explained approximately 38% to 40% of the data's variation. Because heart disease, high blood pressure, urinary tract disease, and diabetes have effects on the kidneys, the four most sensitive markers of kidney disease were examined (urinary enzymes AAP and NAG and urinary proteins albumin and RBP). Persons reporting any of these diseases had higher levels of the urinary proteins and enzymes, as expected. Diabetes had the most pronounced effect on the kidneys. This analysis indicated that, while self-reports of some conditions might be imperfect and the medical tests might not be highly sensitive in identifying disease, reported illnesses were associated with some laboratory measures of the related organ systems; some consistency was found between medical tests and self-reports of disease. This was true particularly for the kidney tests and measures of anemia. Associations between immune system tests and the potentially related illnesses and symptoms were not clear.

DISCUSSION

Study Strengths

The study design chosen had a number of advantages. First, the study participants were randomly selected from the population, improving the generalizability of the results to residents living around the MMR. Second, the comparison area selected was similar in terms of demographics to the target areas, providing a contemporary and similar population (with the exception of exposure) for use in comparing symptom and illness prevalence. The general lack of observed confounding might indicate that the frequency matching for age and sex and the selection of Brewster for the comparison population provided a similar comparison group in which confounding factors were not differentially distributed. This improved the reliability of analyses of conditions that were too rare to allow for adjustment of potential confounders. Third, a proportion (approximately one-third) of the target area participants had documented completed exposure pathways (contaminated drinking water). Fourth, the study included biologic tests to provide objective measures of organ system dysfunction. Fifth, the study used trained interviewers and a standardized questionnaire to obtain the most complete and unbiased interviews possible. Sixth, over 900 people were participated in the study, representing a large proportion of potentially affected residents and providing good statistical power, particularly for blood lead and medical test results.

Study Limitations

The study design also had several limitations. First, there was no information on individual exposure within the target communities. While two of the target areas had a high proportion of persons who had at one time used private well water and had contaminated groundwater plumes that had been documented (1), information was not available on individual household wells of study participants. Further, data on the actual level of contamination in individual wells, the amount of groundwater consumed by individuals, and the duration of individual consumption of groundwater were not available. In addition to the areas with documented exposure pathways, two of the study areas had either only potential or no exposure pathways. The communities surrounding the MMR have expressed concern about air emissions from the MMR; however, no air emission data exist to determine the actual level and duration of the possible exposure (1). Within the two communities with contaminated groundwater, too few participants were available to be able to distinguish an effect between air exposure alone and air plus groundwater exposure. The lack of precise exposure data made it impossible to infer cause and effect relationships from the results of this study.

Second, recall or reporting bias might have overestimated health outcomes among target area participants and those who had used well water or underestimated health outcomes among comparison area participants, either of which would have tended to over estimate the

exposure-outcome relationship. The possible presence of recall bias was examined using techniques similar to Ozonoff (9); however, these adjustment procedures could not eliminate the effect of this bias or prove that recall bias existed. There appeared to be little reporting bias or confounding due to concern about environmental problems when current health conditions were examined, given the lack of statistically significant differences and qualitative differences in ORs between those concerned and those not concerned about environmental or chemical hazards. It had little impact on analysis or conclusions. Persons reporting concern about environmental problems tended to report more conditions with first onset after moving to the current home than persons not reporting such concern, however the presence of recall bias cannot be proven nor ruled out. Anecdotal reports indicated that some people in the Ashumet Valley neighborhood had been maintaining diaries of health conditions. However, whether any study participants had been maintaining health diaries is unknown. An increased level of community concern might have accounted for the high number of health conditions reported in Ashumet Valley, principally those defined as having first onset after moving to the current home. However, the methods used in this study could neither confirm nor disprove that participants in Ashumet Valley reported health conditions more completely than participants in the comparison area. None of the self-reported health conditions were verified using medical records, although it is unlikely that medical records could be used to verify symptoms. The similarity in reporting of other situations that might be endangering participants' health indicates similarity in concern about health, aside from environmental and chemical hazards in participants' neighborhoods. This report examined

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

the effect of concern on reporting of health outcomes, but was not able to examine the effect of knowledge of exposure on reporting of health outcomes due to the widespread knowledge of environmental contamination and the definition of exposure (proximity to MMR).

Third, misclassification of exposure status might have biased the results. Well sampling data indicated that most wells were not contaminated and estimated that approximately 50 people in the Briarwood subdivision and 100 people in the Ashumet Valley subdivision were affected by the contaminated groundwater (2). This study included 100 people from each of these two neighborhoods and it was not known whether their wells were contaminated. Most of these residents had not been using private wells for several years, reducing the ability to detect health effects from ongoing exposure. Misclassification bias resulting from combining all persons who had lived in the area where well water had been contaminated into an "exposed" category would tend to underestimate any increases in health outcomes if they existed. When an additional analysis was conducted to exclude people who lived in the areas with groundwater contamination, yet did not consume well water, no differences in results were found. However, within the group of persons who used well water, some might not have been exposed to contaminated water. Without individual exposure data, some misclassification of exposure is likely. Misclassification of exposure would tend to underestimate the exposure-illness associations observed. In addition, since individual exposure data were not available, a dose-response relationship could not be

assessed. Because air monitoring data were not available, potential differences in airborne exposures could not be assessed.

Fourth, there was the potential for confounding due to other environmental exposures that could not be controlled for in this study. One potential source of confounding that could not be controlled was the possibility of PCE exposure from the lining of cement water distribution pipes in the four target area communities, but not in the comparison area community. These pipes were installed beginning in the late 1960s. Typical concentrations in affected lines in Falmouth ranged from 1,600 to 7,750 micrograms per liter ($\mu\text{g/L}$) at low usage (dead end) sites to 1.5 to 80 $\mu\text{g/L}$ at medium and high usage sites (3,21,22). In comparison, the highest concentration of PCE found in a private well in the Ashumet Valley area of Falmouth was 70 $\mu\text{g/L}$ and the highest concentration found in on-site groundwater was 430 $\mu\text{g/L}$ (2). In 1980, the Massachusetts Department of Environmental Protection instituted a program for reducing PCE concentrations in the existing pipes by regular flushing to lower the levels below 40 $\mu\text{g/L}$ (3). Aschengrau et al. (3) found increased risk of leukemia and bladder cancer among those exposed to PCE (defined as "ever" exposed, level not defined) in drinking water. PCE in large doses has also been found to produce central nervous system effects (23), which could account for some of the elevated ORs found in this study. However, the elevated ORs for seizures or epilepsy in Picture Lakes and tremors or shakes in Briarwood were based on only 3 cases each. Further, because the pipes were used in all four of the target area communities, it would have been anticipated

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

that any effects would have been seen in all four communities rather than just one or two.

The actual dosage of PCE that study participants received is unknown and the levels reported in the literature which have been found to cause health effects in animals are 150 to 1,000 times greater than the most contaminated drinking water ever reported in the literature (22). Additional confounders could be exposure to chemicals from the nearby airport and cranberry bogs (3,4).

Fifth, the fewer number of years Briarwood residents had lived in the community meant that these persons had, on average, a shorter "at-risk" period, independent of exposure. Symptoms and illnesses with first onset since the participant moved to their current addresses were analyzed to remove preexisting conditions which might obscure exposure-induced illness. However, the shorter residency of Briarwood participants might have underestimated the occurrence of symptoms and illnesses in relation to the comparison area. Only when sample sizes were sufficient could ORs be adjusted for the number of years participants had lived in their homes. When this adjustment was done, ORs often increased somewhat. When the sample size was not sufficient, no adjustments could be made to the crude results and the results might have underestimated the true occurrence. Similarly, the longer duration of years living in Ashumet Valley might have lead to overestimates of the occurrence of health effects.

Sixth, the relatively low participation rate (approximately 51 % to 61 %) could mean that the results were not representative of the population at large. Residents from both the target and comparison areas with health problems might have been more or less likely to participate. Further, residents who were more aware of the environmental issues near the MMR might have recalled health events to a different degree which might have affected their decision to participate in the study. However, the participation rates were similar between the target and comparison areas and study participants were demographically similar to the communities from which they were selected. The actual impact of the low participation rate on the results of the study could not be determined.

Seventh, the study shared the usual limitations of all symptom and illness prevalence studies. These include the lack of specificity of the outcome measures, the lack of verification of self-reports of health problems, and the testing of multiple hypotheses during the analysis of the data (40 symptoms and illnesses and 21 medical tests were each analyzed several different ways). The large number of health effects and medical tests, however, provided for a broad assessment of health which was appropriate given the exploratory nature of the study.

Interpretation

The Ashumet Valley and Briarwood areas were included in the study because of the documented groundwater contamination in these areas and a history that private well water had been used as a primary source of water used in these homes. No information was available to document airborne exposures to chemicals from the MMR. The Forestdale and Picture Lakes areas were included in the study at the request of the community. No documented exposure pathways existed and interpretation of health findings in these areas was, therefore, hampered.

Among the four target areas, only the two areas with water/air pathways (Ashumet Valley in particular) were found to have substantively higher rates of reported illnesses and symptoms with first onset since participants moved to their current homes. Further, the findings of higher rates of reported symptoms and illnesses in the two water/air pathway communities (Ashumet Valley and Briarwood) were plausible, given the documented groundwater contamination that occurred. The higher number of elevated conditions with first onset since the participants moved to their current homes rather than current conditions was consistent with the fact that most persons who had ever used well water were no longer using it at the time of the study. Participants in Briarwood, which had the largest number of current (at the time of the study) well water users, tended to have more than expected (based upon observed numbers in the comparison area) numbers of current illnesses. The number

of current well water users in Briarwood was too few to examine the health of these participants separately to determine the effects of current exposure. Well sampling data were not available to determine whether the private well water currently being used by Briarwood residents was contaminated.

The actual level of contamination that individuals might have been exposed to is unknown; therefore, it is unknown whether participants' wells in Ashumet Valley were more contaminated than those of Briarwood participants. Briarwood residents used well water more recently than residents in Ashumet Valley which would seem to indicate that, if the reported health outcomes were associated with exposure to contaminated groundwater, the effects were not limited to a short term duration. However, many of the elevated rates of health conditions in Ashumet Valley were restricted to those with first onset since participants moved to their homes and not current conditions, which would be consistent with past and not current exposures. The findings of more elevated symptoms and illnesses in Ashumet Valley than Briarwood could be due to the shorter duration of time that participants had lived in Briarwood than in Ashumet Valley. The difference in the number of years residency might explain why Ashumet Valley participants (mean 13.4 years residency) had more reports of conditions with first onset since the participants moved to their current homes than Briarwood participants (mean 9.0 years residency). The mean number of years residency in the comparison area was 11.7 years. When the sample size was sufficient to adjust for the number of years participants had lived in their current homes, ORs for

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Briarwood tended to increase. This adjustment could not be made for many illnesses and symptoms due to sparsity of data, so no conclusive statement can be made regarding the impact of differences in mean number of years residency between the communities.

In Ashumet Valley, 5 of 38 current health conditions were statistically significant, one more than would be expected due to chance alone. Six of 38 conditions had ORs which were ≥ 2.0 . Ashumet Valley had a much larger number of conditions reported more often when the outcomes were defined as those with first onset since participants moved to their current homes. Ten of 38 conditions with first onset since participants moved to their homes were statistically significant and 15 had ORs which were ≥ 2.0 . This might indicate that their health conditions resolved themselves over time, that they might have occurred when exposure to groundwater was occurring and stopped when it was removed, that the longer residency time in Ashumet Valley led to a longer at-risk period, or that persons in Ashumet Valley had different recall of past health events than those in the comparison area. The types of illnesses reported in the water/air pathway areas were varied, including respiratory, gastrointestinal, blood related, and arthritic conditions. Symptoms tended to be nonspecific. Respiratory conditions appeared to be elevated.

In Briarwood, four current health conditions (1 illness and 3 symptoms) were statistically significant, the number that would have been expected due to chance alone. Four current illnesses and two symptoms were reported more than twice as often as in the

comparison area. When the definition was onset since participants moved to their homes, 1 illness was statistically significant while 5 of 14 symptoms were statistically significant. Four of 24 illnesses and four of 14 symptoms with first onset since participants moved to their homes were reported at twice the rate as in the comparison area. These data might suggest that the health effects noted (which have since resolved) could be due to past exposures. The data might also indicate that primarily only symptoms were elevated in Briarwood and not physician-diagnosed illnesses.

In Forestdale, fewer than expected numbers of conditions were found to be statistically significant and few conditions were reported at more than twice the rate in the comparison area. It appeared that participants in Forestdale had similar health conditions as participants in the comparison area.

In Picture Lakes, 4 of 24 current illnesses and 2 of 14 current symptoms were reported statistically significantly more often than in the comparison area. The finding of elevated reports chest pain was consistent with the finding of elevated reports of heart disease. The larger number of statistically significant findings could be due to the larger sample size (199 participants compared with approximately 100 in each of the water/air pathway areas), although this was not true in Forestdale (which also had the expanded sample size). Any increases in illness rates between the two years of data collection were also not consistent between Forestdale and Picture Lakes, reducing the possibility that a time-specific

factor contributed to the increased findings in Picture Lakes. The expected number (2) of statistically significant illnesses with first onset since participants moved to their current homes was found, but more statistically significant findings were found for symptoms with first onset since participants moved to their current homes (3). The greater number of findings for current health conditions rather than conditions with first onset since participants moved to their current homes might indicate that some of these conditions were preexisting prior to participants moving to their current homes. It might also indicate a greater awareness of current health. No particular pattern of symptoms or illnesses was identified.

The greater degree of reporting of symptoms than illnesses might indicate that health effects due to chemical exposures are not easily defined. They might also indicate differential recall and reporting between the target and comparison areas whereas physician-diagnosed illnesses might be more reliable. This could not be determined with the data collected.

Multiple Statistical Tests

Because many statistical tests were performed, it is anticipated that some findings of statistical significance might have been due to chance alone. An alpha level of 0.1 was selected as the level of statistical significance to be used in this study's calculations. This means that using the statistical procedures, one could expect that on average, about 10% of the time when an odds ratio was considered to be statistically significantly different from 1.0,

meaning that the occurrence of a health condition was considered to be statistically significantly different in the target area as compared to the comparison area, the occurrence of the health condition was actually similar in the target and comparison areas. Thirty-eight health conditions with two definitions (currently having the condition and having first onset since participants moved to their homes) were examined for 7 groupings (4 individual target areas, the water/air combined target area, the air-only combined target area, and the well water users only). This means that a minimum of $38 \times 7 \times 2 = 532$ ORs, CIs, and p-values were calculated and it could be expected that 53 (0.1×532) conditions would be statistically significant ($p < 0.10$) due to chance alone. Of course, it is impossible to determine which (if any) findings were due to statistical chance. In many instances, ORs, 90% CIs, and p-values were calculated when the observed numbers of cases were small. More than half of the illnesses had 5 or fewer cases of illnesses in each study area making the results subject to fluctuation. The reader is cautioned not to place too much emphasis on any one finding, particularly a finding based on a small number of observed cases.

Biologic Plausibility of Findings and Comparison to the Literature

The health conditions found to be associated with living in the target areas were biologically plausible given the contaminants in the water and possibly air. However, the

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

toxicologic literature suggests that these effects are not expected with low level exposures (4,22,24,25,26).

Two large, recent studies of humans with documented exposure to TCE (27,28) and benzene (29), plus other VOCs, found some results similar to the present study. The findings from the TCE and Benzene Subregistries found that persons exposed to TCE or benzene had higher rates of urinary tract disease and anemia than reported national rates. These conditions were elevated in at least one of the target areas. The subregistries also found deficits in asthma, as was the case in Picture Lakes. However, contrary to the findings of this study, the TCE subregistry found elevated rates of kidney disease and diabetes and lower rates of chronic bronchitis, hayfever, and arthritis. Benzene registrants also had lower rates of arthritis, contrary to the findings of this study.

A recent ATSDR study conducted in Arizona (Disease and Symptom Prevalence Survey, Tucson International Airport Site, Tucson, Arizona, draft for public comment) found that almost every queried health condition was reported more often in participants who lived in an area that once had TCE contaminated groundwater as compared to participants who lived in an unexposed comparison community. Those findings contrast with this study which found much lower numbers of elevated health conditions. Another ATSDR study (12) of a California community near an air force base with contaminated local drinking water had some findings similar to those in this study. Both studies found that persons in target areas

reported more ulcers and other stomach disease and bowel and intestinal problems than did persons in comparison communities. However, the California study also found elevated rates of diabetes, asthma, and weakness or paralysis while this study found deficits in these conditions.

The panel of medical tests used in this study did not find any pattern of organ damage or dysfunction for any of the four target areas examined. For health conditions known to affect specific organs, the related medical tests often corroborated the self-reported health conditions. This corroboration generally applied to anemia and illnesses affecting the kidneys, conditions which were not elevated in the target areas.

Three conditions (chronic bronchitis, ulcers and other stomach disease, and arthritis) were elevated in at least 3 of the 4 target areas. Given that exposure pathways were different across the different target areas, it was not anticipated that health effects would be identical. Possible explanations include exposure to similar chemicals across the four areas; the possibility that these conditions could be stress-induced; the possibility that the comparison area had unusually low prevalences for these conditions; the small number of cases (for bronchitis and ulcers) leading to unstable estimates; reporting bias; and chance. When the analysis of chronic bronchitis was restricted to persons ages 40 years and older, chronic bronchitis was found to be elevated in only Ashumet Valley. Typically, chronic bronchitis is not diagnosed in people until age 50 (30). In addition to the comparison area

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

used in this study, estimates from the 1992 National Health Interview Survey (NHIS) (31) (Appendix A) could be used as another reference for expected background prevalences of various health conditions. The NHIS estimated that for persons living in the Northeastern part of the U.S., the prevalence of arthritis was 13% compared to 12% found in the comparison area; the prevalence of chronic bronchitis was 5% compared to 2% in the comparison area; and 1.2% for ulcers alone compared to 1.9% for ulcers and other stomach disease in the comparison population. The NHIS also reported a prevalence of 1.3% for chronic indigestion and 1.3% for gastritis. The reported prevalence of arthritis was similar between the comparison area and the NHIS and the observed numbers were large removing two possible explanations for the across-the-board elevations in arthritis. The finding that the comparison area had less than half the prevalence of chronic bronchitis compared to the national study might indicate that the rates observed in the target areas were not elevated compared to national averages. Because the NHIS survey separated ulcers from other stomach diseases while this study's questionnaire combined them, it cannot be determined how the observed rates in this study compared to the national averages making the elevated rates of ulcers and other stomach disease difficult to interpret.

Study Results Pertinent to Community Health Concerns Listed in the Public Health Assessment

Specific health concerns were raised by community members during the development of the study protocol, as well as noted in the health assessment (2). One concern noted in the health assessment was, "Could loud aircraft noise affect my hearing and other aspects of my health?" The health assessment reviewed three studies that indicated that a relationship exists between loud or continual aircraft noise and adverse health effects, including cardiovascular effects. Participants in Picture Lakes had higher rates of reported cardiovascular conditions, including high blood pressure, heart disease, and chest pain, which could be related to the noise. However, of the four target areas, participants in the other three target areas lived closer to the runways on base (runways located in the south eastern area of the MMR) and these areas generally did not have elevated rates of cardiovascular conditions.

Regarding birth defects, this study found few reports of birth defects and a similar number in the target and comparison areas. Asthma was also reported to be a health concern, yet the study found generally fewer reports of asthma in the target areas than in the comparison area. Rashes were another reported concern that was found to be similar in target and comparison area participants indicating that residence near the MMR was not associated with increased reports of rashes. Many health concerns regarding cancer could

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

not be adequately addressed by this study due to the rarity of the condition. In general, cancer was not found to be elevated among study participants.

The public health assessment (2) reviewed the different chemicals found in groundwater and evaluated their potential for health effects. Given the low levels found in the groundwater, noncancer endpoints were considered unlikely. 1,2-DCA ingested in large amounts results in nausea, vomiting, and diarrhea, liver damage, and lung effects such as bronchitis and edema. This study did not find increased reports of nausea or liver disease or medical tests results indicative of liver disease. Chronic bronchitis was reported more often in 3 of the four target areas (not Forestdale). However, levels of exposure at the time of the study were assumed to be much less and would not be expected to result in these health effects.

Blood lead levels were generally low and not expected to cause adverse health effects.

Chronic phenol ingestion of 10 to 240 milligrams per person per day can produce diarrhea, mouth sores, and irritation (2). No other studies in humans identified adverse effects in other organs (2). In this study, nausea was elevated in Forestdale, but in none of the other areas. However, Forestdale residents were not considered to be at risk of ingestion of phenols.

1,1-DCA has been found to produce kidney disease and delayed growth of offspring in rats, but at levels 1,000 times higher than the maximum concentration detected in private wells in Ashumet Valley (2). This study found lower reports of kidney disease and no evidence of increased kidney damage in persons in the target areas, with the possible exception of Picture Lakes which had a higher proportion of persons with elevated urine albumin.

The public health assessment (1) noted that dermal exposure to soil contaminated with polychlorinated biphenyls (PCBs) or polycyclic aromatic hydrocarbons (PAHs) might be related to chloracne and skin rashes. This study did not find elevated numbers of skin rashes.

TCE and PCE have been shown to have some central nervous system effects (5,22); however, the study found little in the way of neurologic effects. Persons in Ashumet Valley had twice the rate of self-reported anxiety, nervousness, or depression with first onset since moving to their current homes than did persons in the comparison area. Persons in Briarwood had three times the rate of self-reported tremors or shakes (but only 3 cases were reported in Briarwood) since moving to their homes as did persons in the comparison area. Neither of these conditions were elevated when defined as currently having the condition at the time of data collection. Persons in Briarwood reported more current weakness or

paralysis or numbness and persons in Picture Lakes reported more current seizures or epilepsy, although very few cases of these were reported.

Cancer Assessment

This study asked participants about cancer; but there were limitations to the interpretation of cancer data, including: the small numbers of cases observed, the differing periods of latency required, unknown exposures before moving to the current residence, and the possibility that persons with cancer might have died before participating in the study. Also, the reliability of self-reports of cancer was not clear. Some participants who reported having cancer reported that they did not know what kind of cancer they had. Most of the cancers reported in the study were skin cancers and most cancers were reported to have been treated and not present at the time of the study. Two of five persons who reported currently having a cancer of the blood had this diagnosed before moving to their current homes. For those participants who reported developing any type of cancer after moving to their current homes, the average time between moving to the current homes and having cancer diagnosed was 8 years with a range of 0.4 to 30 years. Analyses conducted in this study did not factor in a latency period. More detailed studies of cancer incidence on the Upper Cape, based on the state cancer registry and case-control study designs, have already been conducted (2-4), and the reader is referred to these more comprehensive assessments of cancer incidence. While rates of lung cancer were found to be elevated in these other investigations, this study

did not have any participants who reported having lung cancer with first onset since moving to their current homes or currently having lung cancer. Because previous address of study participants was not available, it was not possible to determine whether participants had lived at other places on the Cape or were new to the area.

CONCLUSIONS

1. A total of 908 people were included in the health study in May and June of 1993 and October of 1994 including 102 people in Ashumet Valley, 98 people in Briarwood, 202 people in Forestdale, 199 people in Picture Lakes, and 307 people in the comparison area.
2. A majority of participants from the two communities with contaminated groundwater plumes indicated that their households had once used well water as the primary source of drinking, cooking, and bathing water (92% in Ashumet Valley and 89% Briarwood). At the time of interview, one participant in Ashumet Valley and 26 participants in Briarwood indicated they had used private well water for domestic uses within the past 60 days. In Forestdale 52% of participants and 5% of Picture Lakes participants indicated their households had ever used well water, although groundwater in these two areas were not affected by contamination.
3. Blood lead levels were similar between the four target communities surrounding the Massachusetts Military Reservation (Ashumet Valley, Briarwood, Forestdale, and Picture Lakes) and similar to the comparison areas and national averages.

4. Similar numbers of adverse pregnancy outcomes were reported in the target and comparison areas.
5. The results of the medical tests indicated no pattern of organ system dysfunction for any of the four target areas.
6. Eleven of twenty four self-reported illnesses, with first onset since the participants moved to their homes, were reported more often among Ashumet Valley participants than among comparison area participants. The six statistically significant conditions were: anxiety, nervousness, or depression; hayfever or other respiratory allergy; pneumonia; thyroid disease; anemia; and arthritis, rheumatism or other joint disease. Five reported conditions were not statistically significant, but were reported at least twice as often in Ashumet Valley as in the comparison area: heart attack, heart disease or other heart problems; chronic bronchitis; ulcers or other stomach disease; bowel or intestinal problems; urinary tract disease; and cancers of the blood.

Four current conditions were reported more frequently by participants in Ashumet Valley (chronic bronchitis, ulcers or other stomach disease, bowel or intestinal problems, and arthritis or other joint disease). Chronic bronchitis and ulcers were statistically significantly more common in Ashumet Valley.

Possible factors related to the large number of reported health conditions, with first onset after moving into the current home, could have been due to past exposure to contaminated groundwater, the greater number of years Ashumet Valley participants had lived in their homes (average of 13.4 years) compared to those in the comparison area (average of 11.7 years), differences in recall of health conditions between persons living in Ashumet Valley and the comparison area, or other reasons. Some of these findings (ulcers, cancers of the blood) were based on very few cases of illness and might be more susceptible to chance variations. By the time of the study, the health of participants from Ashumet Valley was similar to that of comparison area participants, other than the four chronic conditions mentioned above.

7. Participants living in the Briarwood area reported five types of illnesses (with first onset since participants moved to their homes) more often than did participants from the comparison area: tremors or shakes; hayfever or other respiratory allergy; pneumonia; and ulcers or other stomach disease. Only pneumonia was statistically significant. The increased reporting of ulcers and chronic bronchitis were based upon only 3 cases each. Five current (at the time of the study) health conditions were reported by Briarwood participants more often than by comparison area participants (weakness or numbness, chronic bronchitis, ulcers or other stomach disease, urinary tract disease, and arthritis). Arthritis was the statistically significant finding. Chronic

bronchitis was not elevated in the age group considered most at risk (age 40 years or older).

Participants from Briarwood reported somewhat more than expected (relative to the comparison area) numbers of illnesses with first onset since participants moved to their homes and current health conditions. Possible factors related to these findings could have been past exposure to contaminated groundwater, differences in recall of health conditions between persons living in Briarwood and the comparison area, or other reasons. On average, Briarwood participants had lived in their homes for somewhat less time (mean 9.0 years) than participants from the comparison area (mean 11.7 years), and conditions with first onset since moving to the current home may be underestimated. Some of these findings (ulcers, chronic bronchitis, urinary tract disease, tremors or shakes) were based on very few cases of illness and might be more susceptible to chance variations. Most of the elevated health conditions were not statistically significant.

8. Participants from Forestdale reported similar numbers of symptoms and illnesses as did participants from the comparison area. No patterns of excess health problems were noted, although Forestdale participants reported more cases of arthritis than did comparison area participants.

9. Participants from Picture Lakes reported two illnesses, with first onset since participants moved to their homes, more often than did comparison area participants (high blood pressure and ulcers or other stomach disease) and both of these conditions were statistically significant. Five current illnesses were reported more often by Picture Lakes participants than comparison area participants and four were statistically significant (Seizures or epilepsy [not statistically significant], heart disease, chronic bronchitis, ulcers or other stomach disease, and arthritis or other joint disease). Picture Lakes participants reported half as much asthma as in the comparison area.

Possible factors related to these findings might include a larger number of preexisting health conditions, a greater awareness of health problems by Picture Lakes residents than by comparison area residents, an unknown exposure source, or some other reason. The finding for seizures or epilepsy was based on only 3 reported cases.

10. Higher numbers of reported cases of chronic bronchitis, ulcers or other stomach disease, and arthritis were reported in the communities surrounding the MMR.

RECOMMENDATIONS

1. Higher numbers of reported cases of chronic bronchitis, ulcers or other stomach disease, and arthritis were reported in the communities surrounding the MMR. Additional followup activities may be recommended for study participants reporting these conditions in order to evaluate the reports; determine their specific nature, severity, and duration; and to assist participants in evaluating their health effects.
2. The study findings will be discussed with the participating communities to identify and consider community based recommendations based upon the findings of this study.

AUTHORS AND ACKNOWLEDGEMENTS

Authors

Sara Moir Sarasua, MSPH, ATSDR

Michael A. McGeehin, PhD, MSPH, ATSDR

Acknowledgements

Community Assistance Panel Members

Thomas C. Cambareri, Lynda Clark, Donna Dragos, Eduard Eichner, Joel Feigenbaum, PhD, Stetson Hall, Richard Hugus, John Jacobi, James Kinney, Harriet Longley, Mary McEnroe, Richard Prince, Sue Walker, Mary Ann Waygan, Alexander Ziss

Massachusetts Department of Health

Suzanne Condon

Robert S. Knorr, PhD

Centers for Disease Control and Prevention, National Center for Environmental Health

Charles Dodson

Patricia Mueller, PhD

Daniel Paschal, PhD

Robert Vogt, PhD

Agency for Toxic Substances and Disease Registry

Robert W. Amler, MD, MS

Kelli C. Davis, MPH, ATSDR, principal investigator 1992-1994

Louise House, Senior Regional Representative, Region I

Paul A. Jones, MSPH

Jerry Pereira, MPA

Ravishankar A. Rao, MPH, MPA

Fred L. Stallings, MD, MPH

Gina J. Terracciano, DO, MPH

Analytical Sciences, Inc.

Midwest Research Institute

National Opinion Research Corporation

REFERENCES

1. Centers for Disease Control and Prevention. Preventing Lead Poisoning in Young Children. US Public Health Service: Atlanta, October 1991.
2. Agency for Toxic Substances and Disease Registry. Public health assessment for Otis Air National Guard Base/Camp Edwards, Barnstable County, Massachusetts. Atlanta: US Department of Health and Human Services, Public Health Service, 1994.
3. Aschengrau A, Ozonoff D, Paulu C, Coogan P, Vezina R, Heeren T, et al. Cancer risk and tetrachloroethylene (PCE) contaminated drinking water in Massachusetts. Arch Environ Health 1993;48:284-92.
4. Aschengrau A, Ozonoff DM. Upper cape cancer incidence study final report. Boston (MA): 1991.
5. Massachusetts Department of Public Health, Agency for Toxic Substances and Disease Registry. Upper Cape Cod cancer incidence review, final report, draft for public comment. September, 1995.
6. Agency for Toxic Substances and Disease Registry. Toxicological profile for trichloroethylene, Draft for Public Comment. Atlanta: US Department of Health and Human Services, Public Health Service, 1995.
7. Adams PF, Benson V. Current Estimates from the National Health Interview Survey, 1989. National Center for Health Statistics. Vital Health Stat 10(176). 1990.
8. Centers for Disease Control/Agency for Toxic Substances and Disease Registry Subcommittee on Biomarkers of Organ Damage and Dysfunction. Biomarkers of organ damage or dysfunction for the renal, hepatobiliary and immune systems. Summary Report. Atlanta: U.S. Department of Health and Human Services. 1990 Aug 27.
9. Miller DT, Paschal DC, Gunter EW, Stroud PE, D'Angelo J. Determination of lead in blood using electrochemical atomization atom-absorption spectrometry with a l'vov platform and matrix modifier. Analyst 1987;112:1701-4.
10. Ozonoff D, Colten ME, Cupples A, Heeren T, Schatzkin A, Mangion T, et al. Health problems reported by residents of a neighborhood contaminated by a hazardous waste facility. Am J Indust Med 1987;11:581-97.
11. Missouri Department of Health. Jasper County, Missouri superfund site lead and cadmium exposure study. Atlanta: US Department of Health and Human Services, Public Health Service, February 1995.

12. Agency for Toxic Substances and Disease Registry. Biologic indicators of exposure to cadmium and lead, Palmerton, Pennsylvania. Atlanta: US Department of Health and Human Services, Public Health Service, June 1994.
13. Agency for Toxic Substances and Disease Registry. Symptom and illness prevalence with biomarkers health study for Calvert City and Southern Livingston County, Kentucky. Atlanta: US Department of Health and Human Services, Public Health Service, May 1995.
14. Agency for Toxic Substances and Disease Registry. McClellan air force base cross-sectional health study, Sacramento, Sacramento County, California. Atlanta: US Department of Health and Human Services, Public Health Service, January 1996.
15. Agency for Toxic Substances and Disease Registry. Southbend Subdivision health outcomes study, Harris County, Texas. Atlanta: US Department of Health and Human Services, Public Health Service, August 1995.
16. Illinois Department of Public Health. Madison County lead exposure study. Atlanta: US Department of Health and Human Services, Public Health Service, April 1995.
17. Agency for Toxic Substances and Disease Registry. Lead and cadmium exposure study, Galena, Kansas. Atlanta: US Department of Health and Human Services, Public Health Service, January, 1996.
18. Brody DJ, Pirkle JL, Kramer RA, Flegal KM, Matte TD, Gunter EW, et al. Blood lead levels in the US population. JAMA 1994;272:277-91.
19. Centers for Disease Control and Prevention. Preventing Lead Poisoning in Young Children. US Public Health Service: Atlanta, October 1991.
20. US Department of Commerce. Bureau of the Census. Alphabetical index of industries and occupations. 1990 Census of population and housing. January 1992.
21. Webler T, Brown HS. Exposure to tetrachloroethylene via contaminated drinking water pipes in Massachusetts: a predictive model. Arch Environ Health 1993;48:293-7.
22. Demond AH. A source of tetrachloroethylene in the drinking water of New England: an evaluation of the toxicity of tetrachloroethylene and the prediction of its leaching rates from vinyl-lined asbestos-cement pipe. MS Thesis, Massachusetts Institute of Technology, Department of Civil Engineering, August 1982.
23. Agency for Toxic Substances and Disease Registry. Toxicological profile for tetrachloroethylene, update, draft for public comment. Atlanta: US Department of Health and Human Services, Public Health Service, 1995.

24. Agency for Toxic Substances and Disease Registry. Toxicological profile for lead. Atlanta: US Department of Health and Human Services, Public Health Service, 1993.
25. Agency for Toxic Substances and Disease Registry. Toxicological profile for dichloroethene. Atlanta: US Department of Health and Human Services, Public Health Service, 1994.
26. Agency for Toxic Substances and Disease Registry. Toxicological profile for dichloroethane. Atlanta: US Department of Health and Human Services, Public Health Service, 1994.
27. Burg, JR, Gist GL, Allred SL, Radtke TM, Pallos LL, Cusack CD. The national exposure registry--morbidity analyses of noncancer outcomes from the trichloroethylene subregistry baseline data. *International Journal of Occupational Medicine and Toxicology* 1995;4(2):237-57.
28. Agency for Toxic Substances and Disease Registry. National exposure registry trichloroethylene (TCE) subregistry baseline technical report (revised). Atlanta: U.S. Department of Health and Human Services, Public Health Service, December 1994.
29. Agency for Toxic Substances and Disease Registry. National exposure registry, benzene subregistry baseline technical report. Atlanta: US Department of Health and Human Services, Public Health Service, June 1995.
30. Ingram, RH. Chronic bronchitis, emphysema, and airways obstruction. In: Harrison's Principles of internal medicine, Volume 2. Isselbacher, KJ; Martin, JB; Braunwald E, Fauci AS, Wilson JD, Kasper DL (eds). New York, McGraw-Hill, Inc., p. 1201, 1994.
31. Benson V., and Marano MA. Current estimates from the National Health Interview Survey, 1992, National Center for Health Statistics, Vital health Stat 10(189) 1994. Table 60.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

TABLES

Table 1.—Age distribution applied to stratified sampling for selecting residents to participate in the health study.

Age Group (years)	Females	Males	Total
8-14	7%	8%	15%
15-35	16%	14%	30%
36-60	21%	19%	40%
61-75	8%	7%	15%
Total	52%	48%	100%

Table 2.—Comparison of demographic characteristics between total eligible residents and study participants in each study area.

Area	Total	Age (years)				Male (%)	%White	Mean years in home	Mean age
		8-14	15-35	36-60	61-70				
Comparison Eligible* Participants**	1220	183 (15%)	328 (27%)	488 (40%)	221 (18%)	45	96	8.7	39.0
	307	45 (15%)	81 (26%)	128 (42%)	53 (17%)	48	96	11.7	39.7
Ashmet Valley Eligible Participants	367	66 (18%)	79 (22%)	147 (40%)	75 (20%)	47	91	9.7	39.3
	102	16 (16%)	31 (30%)	40 (39%)	15 (15%)	47	93	13.4	37.6
Briarwood Eligible Participants	235	28 (12%)	65 (28%)	108 (46%)	34 (14%)	47	89	8.1	39.8
	98	15 (15%)	30 (31%)	38 (39%)	15 (15%)	47	94	9.0	39.4
Forestdale Eligible Participants	754	127 (17%)	247 (33%)	298 (40%)	82 (11%)	49	95	7.8	35.2
	202	31 (15%)	54 (27%)	85 (42%)	32 (16%)	49	97	11.1	39.5
Picture Lakes Eligible Participants	611	66 (11%)	173 (28%)	258 (42%)	114 (19%)	49	91	10.6	40.9
	199	30 (15%)	53 (27%)	79 (40%)	37 (19%)	48	95	13.4	40.4

* The number of full-time residents between 8 and 75 years of age, living in their current home at least one year (as of 5/92) as determined by the door-to-door canvas done in 5/93.

** The number of randomly selected residents actually participating in the health study.

Table 3.—Demographic characteristics for target and comparison area study participants.

Characteristic	Target Area				Comparison Area*	Chi Square p value
	Ashmet	Briarwood*	Forestdale*	Picture Lakes		
Sex						
Male	48 (47%)	46 (47%)	98 (49%)	96 (48%)	147 (48%)	0.999
Female	54 (53%)	52 (53%)	104 (51%)	103 (52%)	160 (52%)	
Age						
8-14 years	16 (16%)	15 (15%)	31 (15%)	30 (15%)	45 (15%)	0.999
15-35 years	31 (30%)	30 (31%)	54 (27%)	53 (27%)	81 (26%)	
36-60 years	40 (39%)	38 (39%)	85 (42%)	79 (40%)	128 (42%)	
61-75 years	15 (15%)	15 (15%)	32 (16%)	37 (19%)	53 (17%)	
Race						
Black	2 (2%)	1 (1%)	1 (1%)	4 (2%)	2 (1%)	0.613
White	95 (93%)	92 (94%)	196 (97%)	190 (95%)	296 (96%)	
Other	5 (5%)	5 (5%)	5 (2%)	5 (3%)	9 (3%)	
Hispanic						
Yes	2 (2%)	2 (2%)	2 (1%)	3 (2%)	2 (1%)	0.720
No	99 (98%)	96 (98%)	200 (99%)	195 (98%)	304 (99%)	
Income (per annum)						
<\$20,000	10 (10%)	7 (8%)	20 (10%)	37 (19%)	42 (15%)	<0.001
\$20,000-49,999	47 (48%)	61 (63%)	94 (49%)	116 (60%)	174 (61%)	
>\$50,000	40 (41%)	28 (29%)	78 (41%)	40 (21%)	69 (24%)	
Education of head of household						
Less than 12th grade	31 (30%)	23 (23%)	51 (25%)	48 (24%)	75 (24%)	0.787
High school graduate	22 (22%)	31 (32%)	49 (24%)	59 (30%)	83 (27%)	
Technical school/ some college	26 (25%)	29 (29%)	64 (32%)	62 (31%)	92 (30%)	
College graduate or more	23 (23%)	15 (15%)	38 (19%)	30 (15%)	57 (19%)	
Years lived in home						
<8	11 (11%)	64 (65%)	62 (31%)	42 (21%)	70 (23%)	<0.001
8-9	13 (13%)	4 (4%)	45 (22%)	24 (12%)	71 (23%)	
10-19	73 (72%)	22 (22%)	81 (40%)	102 (51%)	142 (46%)	
20-29	5 (5%)	7 (7%)	13 (6%)	26 (13%)	21 (7%)	
30-76	0 (0%)	1 (1%)	1 (1%)	5 (3%)	3 (1%)	
Year of Participation						
May/June 1993	102 (100%)	98 (100%)	100 (50%)	101 (51%)	204 (66%)	<0.001
October 1994	0 (0%)	0 (0%)	102 (50%)	98 (49%)	103 (34%)	
Currently smoke cigarettes?						
Yes	16 (16%)	21 (21%)	24 (12%)	40 (20%)	61 (20%)	0.106
No	86 (84%)	77 (79%)	178 (88%)	159 (80%)	246 (80%)	
Currently drink alcohol?						
Yes	43 (42%)	47 (48%)	93 (46%)	94 (47%)	162 (53%)	0.342
No	59 (58%)	51 (52%)	109 (54%)	105 (53%)	145 (47%)	

* Numbers in column may not add up to the total due to missing data.

Table 4.—Comparison of well water use among the five study areas.

Area	Number and Percent of Participants Whose Household Ever Used Well Water as the Primary Source of Water for:				Average Number of Years Well Water Used for Drinking, Cooking, or Bathing*	Average Number of Years Since Last Used Well Water for Drinking, Cooking, or Bathing* (Range of responses, in years)
	Drinking No. (%)	Cooking No. (%)	Bathing No. (%)	Outdoor Use No. (%)		
Ashumet Valley† (n = 99§)	91 (92)	91 (92)	91 (92)	93 (94)	8.5 (0.8-18.0)	5.7 (0-12.9)
Briarwood† (n = 97)	75 (77)	79 (80)	86 (89)	89 (92)	8.3 (0.7-34.1)	1.7 (0-7.1)
Forestdale (n = 202)	106 (52)	106 (52)	105 (52)	105 (52)	8.9 (0-30.3)	4.9 (0-12.9)
Picture Lakes (n = 198)	9 (5)	9 (5)	8 (4)	8 (4)	15.8 (9.7-25.1)	7.0 (0-48.9)
Comparison Area (n = 303)	35 (12)	36 (12)	36 (12)	41 (14)	8.6 (0-26.6)	9.4 (0-23.6)

* For those ever using well water

† Area with completed water pathway

§ Number of respondents with information on well water use.

¶ Range of responses, in years

Table 5.—Comparison of recent water use among the four target areas and the comparison area.

Area	Number and Percent of Participants Whose Household Used Well Water Within the Past 60 days as the Primary Source of Water for:			
	Drinking No. (%)	Cooking No. (%)	Bathing No. (%)	Outdoor Use No. (%)
Ashumet Valley* (n = 99†)	0 (0)	1 (1)	1 (1)	1 (1)
Briarwood* (n = 97)	6 (3)	17 (17)	26 (27)	26 (27)
Forestdale (n = 202)	17 (8)	22 (11)	22 (11)	23 (11)
Picture Lakes (n=198)	6 (3)	6 (3)	4 (2)	6 (3)
Comparison Area (n = 303)	6 (2)	6 (2)	6 (2)	6 (2)

* Area with completed water pathway

† Number of respondents with information on well water use.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Table 6.—Comparison of blood lead levels between the four target areas and the comparison area.

Area	Geometric Mean Blood Lead Level (Mean $\mu\text{g/dL}$ *)	Standard Deviation of Mean	Range of Blood Lead Levels†	Sample Size
Ashumet Valley	2.8 (1.047)	0.677	0.3-16.7	102
Briarwood	3.2 (1.157)	0.651	0.6-28.6	98
Forestdale	2.8 (1.023)	0.621	0.3-11.3	100
Picture Lakes	2.9 (1.057)	0.806	0.3-42.4	100
Comparison Area	2.7 (0.979)	0.621	0.3-11.3	192

* Micrograms per deciliter

† No child had a blood lead level $\geq 10 \mu\text{g/dL}$.

Table 7. Comparison of reports of health conditions in the 1994 data collection period compared to the 1993 data collection period, comparison area participants only.

Condition	Definition of Time Period of Health Condition	
	Current Health Condition OR (90% CI)*	Health Condition with First Onset Since Participant Moved to Home OR (90% CI)
Anemia	2.0 (0.7-5.7)	1.3 (0.5-3.2)
Anxiety, nervousness, or depression	0.6 (0.2-1.7)	1.0 (0.5-2.0)
Seizures or epilepsy	2.0 (0.2-10.5)†	1.0 (0.1-7.4)†
Tremors or shakes	1.3 (0.3-5.9)	1.0 (0.1-7.4)†
Neurologic or nervous system problems	3.4 (1.1-10.7)§	1.3 (0.5-3.9)
Weakness/paralysis/numbness	3.6 (1.3-9.7)§	3.6 (1.3-9.7)§
High blood pressure	1.2 (0.7-2.2)	0.5 (0.2-1.1)
kidney disease	NC	2.0 (0.2-19.5)†
Urinary tract disease	2.0 (0.5-7.5)	0.5 (0.2-1.3)
diabetes	1.0 (0.3-3.2)	0.6 (0.2-2.1)
eczema / skin problems	1.5 (0.9-2.8)	1.0 (0.5-2.0)
bowel disease	1.1 (0.4-3.2)	2.0 (0.7-5.7)
ulcers/stomach disease	3.0 (0.7-12.7)	6.0 (1.1-32.5)†§
arthritis	1.4 (0.8-2.5)	1.6 (0.9-3.0)
cancer of the blood	1.0 (0.1-7.4)†	0.7 (0.1-4.3)†
other cancer	NC	0.7 (0.2-2.2)
chronic bronchitis	1.0 (0.2-4.1)	1.0 (0.2-4.1)
asthma	0.7 (0.3-1.5)	0.5 (0.2-1.3)
hayfever	0.8 (0.5-1.4)	1.0 (0.5-2.3)
pneumonia	NC	0.7

Table 7. Continued.

Condition	Definition of time period of health condition	
	Current Health Condition OR (90% CI)*	Health Condition with First Onset Since Participant Moved to Home OR (90% CI)
emphysema	0.7 (0.1-4.3)†	1.0 (0.1-7.4)†
heart problems	1.2 (0.5-2.8)	1.4 (0.5-3.8)
gall bladder disease	NC	1.2 (0.4-4.0)
thyroid disease	1.2 (0.4-4.0)	0.5 (0.1-3.0)†
Chest pain	0.6 (0.2-1.7)	0.9 (0.5-1.8)
Tingling	1.1 (0.6-1.9)	1.3 (0.7-2.2)
Numbness	0.9 (0.5-1.6)	1.0 (0.5-1.8)
Blackouts	NC	1.6 (0.6-4.5)
Irritated nose	1.0 (0.4-2.7)	0.8 (0.2-3.1)
Headaches	1.1 (0.6-2.1)	0.8 (0.5-1.5)
Poor coordination	6.2 (1.9-20.5)§	2.0 (0.5-7.7)
Watery eyes	0.8 (0.4-1.4)	0.7 (0.3-1.4)
Nausea	0.7 (0.1-4.3)†	0.5 (0.1-1.8)
Drowsiness	1.5 (0.8-3.0)	1.4 (0.7-2.6)
Dizziness	0.9 (0.4-2.1)	0.7 (0.3-1.3)
Trouble sleeping	2.3 (1.3-4.2)§	1.1 (0.5-2.1)
Bleeding gums	4.2 (1.6-10.8)§	1.4 (0.5-3.7)
Rashes	2.5 (1.3-4.8)§	0.8 (0.4-1.5)

* Odds ratio and 90% confidence interval. OR > 1.0 indicates 1994 higher prevalence than 1993.

† Only one case was observed in at least one of the two time periods.

§ Statistically significant difference between the two years of data collection, $p < 0.10$.

¶ Not calculated, no cases observed in at least one of the two time periods and the OR was not calculated.

Table 8.—Comparison of the number of participants from the target areas with water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of illness since they moved to their homes.

Exposure groups and disease	Disease		OR (90% CI)*	Was Confounding Assessed?†
	Yes	No		
Frequent periods of anxiety, nervousness, or depression?				
Water/Air Pathway	21	179	1.4 (0.8-2.3)	Yes
Air-only Pathway	22	378	0.7 (0.4-1.1)	Yes
Comparison area	24	282	1.0	
Seizures or epilepsy?				
Water/Air Pathway	1	199	NC§	No
Air-only Pathway	3	398	0.8 (0.2-2.9)	No
Comparison area	3	304	1.0	
Tremors or shakes?				
Water/Air Pathway	4	199	2.1 (0.6-7.2)	No
Air-only Pathway	3	398	0.8 (0.2-2.9)	No
Comparison area	3	304	1.0	
Neurologic or nervous system problems?				
Water/Air Pathway	3	197	0.5 (0.2-1.3)	No
Air-only Pathway	13	388	0.8 (0.4-1.7)¶	Yes
Comparison area	10	296	1.0	
Weakness or paralysis or numbness in arms or legs not due to stroke?				
Water/Air Pathway	6	193	0.8 (0.4-2.0)	No
Air-only Pathway	15	385	0.9 (0.5-1.8)**	Yes
Comparison area	11	296	1.0	
High blood pressure (15-75 yrs of age)				
Water/Air Pathway	19	150	1.0 (0.6-1.6)	Yes
Air-only Pathway	54	286	1.4 (1.0-2.2)	Yes
Comparison area	30	229	1.0	
Heart attack, heart disease, or other heart problems? (15-75 yrs of age)				
Water/Air Pathway	14	154	1.7 (0.9-3.3)	Yes
Air-only Pathway	23	316	1.4 (0.8-2.5)	Yes
Comparison area	13	249	1.0	

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Table 8.—Continued.

Exposure groups for Disease	Disease		OR (90% CI)*	Was Confounding Assessed?†
	Yes	No		
Chronic bronchitis?				
Water/Air Pathway	6	193	1.6 (0.6-4.0)	No
Air-only Pathway	6	392	0.8 (0.3-2.0)	No
Comparison area	6	300	1.0	
Asthma?				
Water/Air Pathway	11	189	0.9 (0.5-1.7)	Yes
Air-only Pathway	17	383	0.7 (0.4-1.2)	Yes
Comparison area	19	288	1.0	
Hayfever or other respiratory allergy (not asthma?)				
Water/Air Pathway	26	171	2.1 (1.3-3.5) p<0.05	Yes
Air-only Pathway	38	357	1.5 (0.9-2.4)	Yes
Comparison area	20	279	1.0	
Pneumonia?				
Water/Air Pathway	25	173	2.2 (1.3-3.6) p<0.05	Yes
Air-only Pathway	26	373	1.1 (0.6-1.8)	Yes
Comparison area	19	286	1.0	
Emphysema? (15-75 yrs of age)				
Water/Air Pathway	0	169	NC	No
Air-only Pathway	6	334	1.6 (0.5-5.0)	No
Comparison area	3	259	1.0	
Ulcers or other stomach disease? (15-75 yrs of age)				
Water/Air Pathway	6	163	2.4 (0.8-6.8)	No
Air-only Pathway	14	325	2.8 (1.1-6.9) p <0.10	No
Comparison area	4	258	1.0	
Bowel disease or intestinal problems?				
Water/Air Pathway	10	190	1.6 (0.7-3.3)	Yes
Air-only Pathway	16	384	1.2 (0.6-2.4)	Yes
Comparison area	10	296	1.0	
Gallstones or other gallbladder disease? (15-75 yrs of age)				
Water/Air Pathway				
Air-only Pathway	4	165	0.8 (0.3-2.1)	No
Comparison area	12	328	1.2 (0.5-2.5)	No
	8	253	1.0	
Kidney disease? (15-75 yrs of age)				
Water/Air Pathway	2	167	1.6 (0.3-8.0)	No
Air-only Pathway	3	336	1.2 (0.3-5.2)	No
Comparison area	2	260	1.0	
Other urinary tract disease, including prostate trouble? (15-75 yrs of age)				
Water/Air Pathway	17	151	1.7 (0.9-3.1)	Yes
Air-only Pathway	22	317	1.1 (0.6-1.8)	Yes
Comparison area	16	242	1.0	

Table 8.—Continued.

Exposure groups for Disease	Disease		OR (90% CI)*	Was confounding assessed?
	Yes	No		
Diabetes? (15-75 yrs of age)				
Water/Air Pathway	1	168	NC	No
Air-only Pathway	10	330	0.8 (0.4-1.6)	Yes
Comparison area	10	252	1.0	
Thyroid disease?				
Water/Air Pathway	7	193	2.2 (0.9-5.7)	No
Air-only Pathway	9	391	1.4 (0.6-3.5)	No
Comparison area	5	302	1.0	
Anemia or other blood disorders (not cancer)?				
Water/Air Pathway	16	183	1.7 (0.9-3.1)	Yes
Air-only Pathway	14	386	0.7 (0.4-1.3)	Yes
Comparison area	15	288	1.0	
Cancers of the blood, leukemia, hodgkins disease, or lymphoma?††				
Water/Air Pathway	4	196	1.6 (0.5-5.0)	No
Air-only Pathway	2	399	0.4 (0.1-1.5)	No
Comparison area	4	303	1.0	
Other cancer or malignancy?§§				
Water/Air Pathway	9	191	1.4 (0.6-3.5)	No
Air-only Pathway	9	392	0.7 (0.3-1.7)	No
Comparison area	10	297	1.0	
Arthritis, rheumatism or other joint disease?				
Water/Air Pathway	22	177	1.0 (0.6-1.6)	Yes
Air-only Pathway	58	340	1.3 (0.9-1.9)	Yes
Comparison area	35	271	1.0	
Eczema or other skin problems?				
Water/Air Pathway	17	182	1.1 (0.6-1.9)	Yes
Air-only Pathway	25	368	0.7 (0.4-1.1)¶¶	Yes
Comparison area	24	280	1.0	

* Odds ratio and Mantel Haenszel 90% confidence intervals. The comparison area is used as the referent group for each odds ratio.

† When sample size was sufficiently frequent (at least 8-10 cases in each group), the data were modelled using logistic regression to assess confounding. The adjusted values are presented in the three cases in which the adjusted results differed from the crude; otherwise, crude results are presented.

§ NC, OR not calculated when one or more areas had one or fewer cases of disease.

¶ OR for nervous system problems in air-only pathway area adjusting for year of study.

** OR for weakness in air-only pathway area adjusted for year of study.

†† Mean years living in current home prior to diagnosis was 8.8 years with a range of 0.9 to 19.5 years for cancers of the blood.

§§ Cancer: includes 4 cases of intestinal/colon cancer, 3 cases of melanoma, 12 cases of skin cancer, 2 cases of breast cancer, 2 cases of cervical cancer, 3 other, and 2 unknown. Mean years living in current home prior to diagnosis was 10.0 years with a range of 0.4 to 31 years.

¶¶ OR for eczema in air-only pathway area adjusted for current alcohol consumption and year of study.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Table 9.—Comparison of the number of participants from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of symptoms since they moved to their homes.

Exposure Groups	Symptom		OR (90% CI)*	Was Confounding Assessed?†
	Yes	No		
Tingling or prickling in fingers or toes?				
Water/Air Pathway	28	161	1.0 (0.7-1.5)	Yes
Air-only Pathway	64	322	1.1 (0.8-1.6)	Yes
Comparison area	43	247	1.0	
Numbness or the sensation of pins and needles in your fingers and toes?				
Water/Air Pathway	34	157	1.6 (1.0-2.4)	Yes
Air-only Pathway	58	322	1.3 (0.9-1.9)	Yes
Comparison area	34	249	1.0	
Loss of consciousness or blackouts?				
Water/Air Pathway	9	191	1.3 (0.6-2.7)	Yes
Air-only Pathway	18	381	1.3 (0.7-2.4)	Yes
Comparison area	11	293	1.0	
Severe and/or frequent headaches?				
Water/Air Pathway	33	163	1.3 (0.9-2.0)	Yes
Air-only Pathway	56	336	1.1 (0.7-1.6)	Yes
Comparison area	40	264	1.0	
Poor coordination?				
Water/Air Pathway	4	195	1.0 (0.4-3.0)	No
Air-only Pathway	13	387	1.7 (0.7-3.8)	No
Comparison area	6	299	1.0	
Trouble sleeping?				
Water/Air Pathway	22	174	1.2 (0.7-1.9)	Yes
Air-only Pathway	45	346	1.2 (0.8-1.8)	Yes
Comparison area	29	271	1.0	
Frequent periods of drowsiness or fatigue?				
Water/Air Pathway	33	164	2.0 (1.3-3.1), $p<0.05$	Yes
Air-only Pathway	64	329	1.7 (1.1-2.5), $p<0.05$ §	Yes
Comparison area	28	274	1.0	
Dizziness or the sensation of moving while you are actually still (vertigo)?				
Water/Air Pathway	26	171	1.3 (0.8-2.1)	Yes
Air-only Pathway	39	352	1.0 (0.6-1.5)	Yes
Comparison area	31	271	1.0	
Irritation or burning in your nose?				
Water/Air Pathway	11	185	2.5 (1.1-5.5), $p<0.05$	No
Air-only Pathway	14	380	1.6 (0.7-3.3)	No
Comparison area	7	295	1.0	

Table 9.—Continued.

Exposure groups for Symptom	Symptom		OR (90% CI)*	Was Confounding Assessed?†
	Yes	No		
Watery, burning, or irritated eyes?				
Water/Air Pathway	48	142	2.9 (1.9-4.3), p<0.01	Yes
Air-only Pathway	56	328	1.5 (1.0-2.1)	Yes
Comparison area	31	263	1.0	
Bleeding gums?				
Water/Air Pathway	17	180	2.1 (1.1-3.8), p<0.10	Yes
Air-only Pathway	35	355	2.2 (1.3-3.7), p<0.05	Yes
Comparison area	13	286	1.0	
Skin rashes?				
Water/Air Pathway	25	173	1.3 (0.8-2.2)	Yes
Air-only Pathway	43	353	1.1 (0.8-1.7)	Yes
Comparison area	29	269	1.0	
Frequent periods of nausea or vomiting?				
Water/Air Pathway	8	192	1.2 (0.6-2.7)	No
Air-only Pathway	11	390	0.8 (0.4-1.7)	Yes
Comparison area	10	296	1.0	
Chest pain? (15-75 yrs of age)				
Water/Air Pathway	31	135	1.5 (1.0-2.4)	Yes
Air-only Pathway	53	273	1.3 (0.9-1.9)	Yes
Comparison area	33	222	1.0	

* Mantel Haenszel 90% confidence intervals. The comparison area is used as the referent group for each odds ratio.

† When sample size was sufficiently frequent, the data were modelled using logistic regression to assess confounding. In all but one case (drowsiness), the crude and adjusted values were the same and therefore crude results are provided.

§ Model for drowsiness in air-only pathway adjusting for age, current alcohol use, year of study.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Table 10.—Comparison of the number of participants from the target areas with water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently (at the time of data collection) had an illness.

Exposure Groups	Current Illness		OR (90% CI)*
	Yes	No	
Frequent periods of anxiety, nervousness, or depression?			
Water/Air Pathway	15	185	1.5 (0.8-2.7)
Air-only Pathway	24	377	1.2 (0.7-2.0)
Comparison area	16	291	1.0
Seizures or epilepsy?			
Water/Air Pathway	0	200	NC†
Air-only Pathway	3	398	1.2 (0.3-5.2)
Comparison area	2	305	1.0
Tremors or shakes?			
Water/Air Pathway	4	196	1.2 (0.4-3.8)
Air-only Pathway	3	398	0.5 (0.1-1.5)
Comparison area	5	302	1.0
Neurologic or nervous system problems?			
Water/Air Pathway	3	197	0.6 (0.2-1.7)
Air-only Pathway	18	383	1.8 (0.9-3.6)
Comparison area	8	299	1.0
Weakness or paralysis or numbness in arms or legs not due to stroke?			
Water/Air Pathway	10	190	1.4 (0.7-3.0)
Air-only Pathway	18	383	1.3 (0.7-2.4)
Comparison area	11	296	1.0
High blood pressure (15-75 yrs of age)			
Water/Air Pathway	18	151	0.7 (0.4-1.2)
Air-only Pathway	57	283	1.2 (0.8-1.7)
Comparison area	38	224	1.0
Heart attack, heart disease, or other heart problems? (15-75 yrs of age)			
Water/Air Pathway	16	153	1.5 (0.8-2.7)
Air-only Pathway	35	305	1.7 (1.0-2.7)
Comparison area	17	245	1.0

Table 10.—Continued.

Exposure Groups	Current Illness		OR (90% CI)*
	Yes	No	
Chronic bronchitis?			
Water/Air Pathway	12	188	3.2 (1.4-7.1), $p<0.05$
Air-only Pathway	12	389	1.6 (0.7-3.5)
Comparison area	6	301	1.0
Asthma?			
Water/Air Pathway	17	183	1.0 (0.6-1.7)
Air-only Pathway	24	377	0.7 (0.4-1.1)
Comparison area	26	281	1.0
Hayfever or other respiratory allergy (not asthma?)			
Water/Air Pathway	41	159	1.0 (0.7-1.4)
Air-only Pathway	85	316	1.0 (0.7-1.4)
Comparison area	65	242	1.0
Pneumonia?			
Water/Air Pathway	2	198	NC
Air-only Pathway	1	400	NC
Comparison area	0	307	1.0
Emphysema? (15-75 yrs of age)			
Water/Air Pathway	0	169	NC
Air-only Pathway	5	335	1.0 (0.3-2.9)
Comparison area	4	258	1.0
Ulcers or other stomach disease? (15-75 yrs of age)			
Water/Air Pathway	8	161	2.6 (1.0-6.4), $p<0.10$
Air-only Pathway	12	328	1.9 (0.8-4.5)
Comparison area	5	257	1.0
Bowel disease or intestinal problems?			
Water/Air Pathway	12	188	1.7 (0.9-3.5)
Air-only Pathway	10	391	0.7 (0.3-1.4)
Comparison area	11	296	1.0
Gallstones or other gallbladder disease? (15-75 yrs of age)			
Water/Air Pathway	0	169	NC
Air-only Pathway	6	334	NC
Comparison area	1	261	1.0
Kidney disease? (15-75 yrs of age)			
Water/Air Pathway	1	168	NC
Air-only Pathway	4	336	NC
Comparison area	1	261	1.0
Other urinary tract disease, including prostate trouble? (15-75 yrs of age)			
Water/Air Pathway	7	162	1.8 (0.7-4.6)
Air-only Pathway	6	334	0.8 (0.3-2.0)
Comparison area	6	256	1.0
Diabetes? (15-75 yrs of age)			
Water/Air Pathway	2	167	0.3 (0.1-1.0)
Air-only Pathway	14	326	1.1 (0.5-2.2)
Comparison area	10	252	1.0

Table 10.—Continued.

Exposure groups for Disease	Current Disease		OR (90% CI)*
	Yes	No	
Thyroid disease?			
Water/Air Pathway	7	193	1.4 (0.6-3.2)
Air-only Pathway	16	385	1.6 (0.8-3.2)
Comparison area	8	299	1.0
Anemia or other blood disorders (not cancer)?			
Water/Air Pathway	8	192	1.2 (0.6-2.7)
Air-only Pathway	8	393	0.6 (0.3-1.3)
Comparison area	10	297	1.0
Cancers of the blood, leukemia, hodgkins disease, or lymphoma?§			
Water/Air Pathway	0	200	NC
Air-only Pathway	2	399	0.5 (0.1-2.2)
Comparison area	3	304	1.0
Other cancer or malignancy?¶			
Water/Air Pathway	2	198	NC
Air-only Pathway	6	395	NC
Comparison area	1	306	1.0
Arthritis, rheumatism or other joint disease?			
Water/Air Pathway	41	159	1.9 (1.3-2.8), p<0.05
Air-only Pathway	76	325	1.7 (1.2-2.4), p<0.05
Comparison area	37	270	1.0
Eczema or other skin problems?			
Water/Air Pathway	27	173	1.2 (0.8-1.9)
Air-only Pathway	31	370	0.7 (0.4-1.0)
Comparison area	35	272	1.0

* Odds ratio and Mantel Haenszel 90% confidence intervals. The comparison area is used as the referent group for each odds ratio. When sample size was sufficient, the data were modeled using logistic regression. In all but one case, the crude and adjusted values were the same and therefore crude results are provided.

† NC, OR not calculated when one or more areas had one or fewer cases of disease.

§ Two cases of cancers of the blood were diagnosed before the participant moved to his/her current home, with the remaining cases being diagnosed 9 to 19 years after participants moved to their homes.

¶ Cancers include 6 cases of skin cancer, 1 bladder cancer, 1 breast cancer, 1 unknown. One case was diagnosed prior to moving to his or her current home with the remaining cases being diagnosed 4 to 18 years after participants moved to their homes.

Table 11.—Comparison of the number of participants from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently have symptom.

Exposure Groups	Current Symptom		OR (90% CI)*
	Yes	No	
Tingling or prickling in fingers or toes?			
Water/Air Pathway	27	173	1.0 (0.6-1.5)
Air-only Pathway	59	342	1.1 (0.7-1.5)
Comparison area	43	264	1.0
Numbness or the sensation of pins and needles in your fingers and toes?			
Water/Air Pathway	30	170	1.1 (0.7-1.7)
Air-only Pathway	62	339	1.2 (0.8-1.7)
Comparison area	42	265	1.0
Loss of consciousness or blackouts?			
Water/Air Pathway	2	198	NC
Air-only Pathway	3	398	NC
Comparison area	1	306	1.0
Severe and/or frequent headaches?			
Water/Air Pathway	30	170	1.5 (0.9-2.3)
Air-only Pathway	56	345	1.4 (0.9-2.0)
Comparison area	33	274	1.0
Poor coordination?			
Water/Air Pathway	5	195	1.0 (0.4-2.5)
Air-only Pathway	13	388	1.3 (0.6-2.7)
Comparison area	8	299	1.0
Trouble sleeping?			
Water/Air Pathway	32	168	1.6 (1.0-2.5), $p<0.10$
Air-only Pathway	53	348	1.3 (0.9-1.9)
Comparison area	33	274	1.0
Frequent periods of drowsiness or fatigue?			
Water/Air Pathway	34	166	2.0 (1.3-3.2), $p<0.01$
Air-only Pathway	60	341	1.8 (1.2-2.6), $p<0.05$
Comparison area	28	279	1.0
Dizziness or the sensation of moving while you are actually still (vertigo)?			
Water/Air Pathway	13	187	1.1 (0.6-1.9)
Air-only Pathway	26	375	1.1 (0.6-1.8)
Comparison area	19	288	1.0
Irritation or burning in your nose?			
Water/Air Pathway	10	190	1.3 (0.6-2.7)
Air-only Pathway	18	383	1.2 (0.6-2.2)
Comparison area	12	295	1.0

Table 11.—Continued.

Exposure groups for Symptoms	Current Symptom		OR (90% CI)*
	Yes	No	
Watery, burning, or irritated eyes?			
Water/Air Pathway	44	156	1.8 (1.2-2.6), p<0.05
Air-only Pathway	67	334	1.3 (0.9-1.8)
Comparison area	42	265	1.0
Bleeding gums?			
Water/Air Pathway	12	188	1.6 (0.8-3.1)
Air-only Pathway	29	372	1.9 (1.1-3.4), p<0.10
Comparison area	12	295	1.0
Skin rashes?			
Water/Air Pathway	16	184	0.9 (0.5-1.6)
Air-only Pathway	36	365	1.1 (0.7-1.7)
Comparison area	26	281	1.0
Frequent periods of nausea or vomiting?			
Water/Air Pathway	2	198	0.8 (0.2-3.2)
Air-only Pathway	10	391	1.9 (0.7-5.1)
Comparison area	4	303	1.0
Chest pain? (15-75 yrs of age)			
Water/Air Pathway	11	158	1.3 (0.7-2.7)
Air-only Pathway	29	311	1.8 (1.0-3.1), p<0.10
Comparison area	13	249	1.0

* Mantel Haenszel 90% confidence intervals. The comparison area was used as the referent group for each odds ratio. When sample size was sufficiently frequent, the data were modelled using logistic regression. In all cases, the crude and adjusted values were the same and, therefore, crude results are provided.

Table 12.—Most recent occupations of study participants.

Standard Occupational Code	Description	Percent
0005-0037	Executive, administrative, and managerial occupations	13.1
0043-0105	Professional specialty occupations	6.8
0155-0164	Teachers, counselors, and librarians	5.8
0174-0198	Other specialty occupations	2.3
0203-0235	Technicians and related support occupations	3.6
0243-0276	Sales occupations	9.8
0303-0389	Administrative support occupations, including clerical	11.6
0413-0426	Protective service occupations (includes fire, police, guards)	3.1
0433-0469	Service occupations, including food service, health service, cleaning, and personal services	14.0
0474-0498	Farming, forestry, and fishing occupations	9.8
0503-0547	Mechanics and repairers	6.5
0628-0695	Precision production occupations	2.3
0735-0796	Machine operators, assemblers, and inspectors	1.0
0804-0856	Transportation and material moving occupations	2.3
0869-0889	Handlers, equipment cleaners, helpers and laborers	1.9
0903-0905	Military	0.7
0901-0917	Other (retired, students, homemakers, unemployed, etc.)	14.3

Table 13.—Most recent industry of participants

Standard Industry Code	Industry	Number	Percent (%)
0012-0032	Agriculture, forestry, and fisheries	7	1.0
0060	Construction	47	6.6
0111-0392	Manufacturing	41	5.8
0410-0472	Transportation, communication, and other public utilities	44	6.2
0502-0571	Wholesale trade	12	1.7
0580-0691	Retail trade	116	16.4
0700-0712	Finance, insurance, and real estate	38	5.4
0721-0760	Business and repair services	26	3.7
0762-0791	Personal services	20	2.8
0800-0810	Entertainment and recreation services	10	1.2
0812-0893	Professional and related services (includes 65 (9.2%) teachers)	190	26.9
0901-0931	Public administration	38	5.4
0932-0960	Military	18	2.5
0961-0990	Other (homemaker, student, unemployed, etc.)	102	14.4

Table 14.—Comparison of numbers of persons having a current or most recent job with potential chemical exposure or associated with the Massachusetts Military Reservation.

Area	Number of Ever Employed Persons Having a Current or Recent Job:		Total Number of Ever Employed Persons
	With Potential Chemical Exposure*,†	Associated With MMR or Military§,¶	
Ashumet Valley	10 (13.9%)	2 (2.8%)	72
Briarwood	11 (13.9%)	2 (2.5%)	79
Forestdale	17 (10.7%)	6 (3.8%)	159
Picture Lakes	21 (13.3%)	8 (5.1%)	158
Comparison Area	26 (10.8%)	0 (0%)	240

* Job defined as having a standard occupation code of 224, 413, 417, 486, 637, 675, 735, 885, 887, 952, 951, 503-535, 537-389, 828-833 or an SIC code of 20, 261, 280, 332, 360, 372, 420, 621, 932, 960.

† Chi-square, 4 df 1.336, $p = 0.855$.

§ MMR/military job defined as standard occupation code of 903, 904, 905 or a standard industry code of 932-960.

¶ Chi-square, 4 df 11.302, $p = 0.023$.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Table 15.—Comparison of responses to subjective question for participants aged 12 years or older.

Area	Number of Participants Responding "Yes" to the Question: "Are you worried or concerned about environmental or chemical hazards in your neighborhood?"
	No. (%)
Ashumet Valley (n = 94)	75 (80%)
Briarwood (n = 90)	76 (84%)
Forestdale (n = 188)	144 (77%)
Picture Lakes (n = 180)	110 (61%)
Comparison Area (n = 282)	84 (30%)

Chi-square for table $p < 0.001$.

Table 16.—Effect of being worried or concerned about neighborhood environmental or chemical hazards on reporting of illnesses with first onset since moved to current home, among participants ages 12 through 75 years of age.

Exposure Groups	Illness		Crude OR	Worry?		OR Adjusted for Worry
	Yes	No		Yes	No	
Frequent periods of anxiety, nervousness, or depression?						
Water/Air Pathway	20	164	1.4	1.8	0.7	1.3
Air-only Pathway	20	347	0.7	0.9	0.4	0.6
Comparison area	23	258	1.0	1.0	1.0	1.0
High blood pressure (15-75 yrs of age)						
Water/Air Pathway	19	150	1.0	0.7	1.0	0.8
Air-only Pathway	54	286	1.4	1.2	1.1	1.1
Comparison area	30	229	1.0	1.0	1.0	1.0
Heart attack, heart disease, or other heart problems? (15-75 yrs of age)						
Water/Air Pathway	14	154	1.7	1.9	0.7*	1.5
Air-only Pathway	23	316	1.4	1.3	1.4	1.4
Comparison area	13	249	1.0	1.0	1.0	1.0

Table 16.—Subjective Continued.

Exposure Groups	Illness		Crude OR	Worry?		OR adjusted for Worry
	Yes	No		Yes	No	
Asthma?						
Water/Air Pathway	10	174	1.0	0.8	2.1	1.3
Air-only Pathway	15	352	0.7	0.8	0.7	0.8
Comparison area	16	266				
Hayfever or other respiratory allergy (not asthma?)						
Water/Air Pathway	24	157	2.5	2.0	0.5	2.1
Air-only Pathway	34	328	1.7	1.5	1.0	1.4
Comparison area	16	258				
Pneumonia?						
Water/Air Pathway	24	158	2.4	0.8	1.5	2.2
Air-only Pathway	22	344	1.0	0.8	1.3	1.1
Comparison area	17	263				
Bowel disease or intestinal problems?						
Water/Air Pathway	10	174	1.6	1.7	0.9*	1.4
Air-only Pathway	15	352	1.2	1.3	0.7	1.0
Comparison area	10	271				
Other urinary tract disease, including prostate trouble? (15-75 yrs of age)						
Water/Air Pathway	17	151	1.7	1.7	1.1	1.5
Air-only Pathway	22	317	1.1	0.9	1.3	1.1
Comparison area	16	242				
Diabetes? (15-75 yrs of age)						
Water/Air Pathway	1	168	NA	NA	NA	NA
Air-only Pathway	10	330	0.8	0.8	1.1	1.0
Comparison area	10	252				
Anemia or other blood disorders (not cancer)?						
Water/Air Pathway	16	167	0.5	2.5	0.5	2.2
Air-only Pathway	14	353	0.8	1.1	1.0	0.8
Comparison area	13	265				
Arthritis, rheumatism or other joint disease?						
Water/Air Pathway	22	161	1.0	1.1	0.5	0.9
Air-only Pathway	58	307	1.4	1.6	1.0	1.3
Comparison area	34	247				
Eczema or other skin problems?						
Water/Air Pathway	14	169	1.0	0.8	0.5*	0.7
Air-only Pathway	21	339	0.7	0.4	1.2†	--
Comparison area	22	257				

Table 16.—Subjective, continued

Exposure Groups	Illness		Crude OR	Worry?		OR Adjusted for Worry
	Yes	No		Yes	No	
Tingling or prickling in fingers or toes?						
Water/Air Pathway	27	147	1.0	1.0	0.4	0.8
Air-only Pathway	61	293	1.1	1.1	0.8	1.0
Comparison area	43	222				
Numbness or the sensation of pins and needles in your fingers and toes?						
Water/Air Pathway	33	144	1.5	1.2	1.8	1.4
Air-only Pathway	56	292	1.3	1.1	1.1	1.1
Comparison area	34	224				
Loss of consciousness or blackouts?						
Water/Air Pathway	9	191	NA	NA	NA	NA
Air-only Pathway	17	349	1.2	1.2	0.6	1.1
Comparison area	11	293				
Severe and/or frequent headaches?						
Water/Air Pathway	29	151	1.3	1.3	1.4	1.2
Air-only Pathway	50	310	1.1	1.1	1.0	1.0
Comparison area	35	244				
Trouble sleeping?						
Water/Air Pathway	21	159	1.2	1.0	1.3	1.1
Air-only Pathway	43	315	1.2	1.1	0.9	1.0
Comparison area	28	247				
Frequent periods of drowsiness or fatigue?						
Water/Air Pathway	32	149	1.9	2.4	1.5	2.0
Air-only Pathway	63	298	1.9	2.8	0.9§	--
Comparison area	28	249				
Dizziness or the sensation of moving while you are actually still (vertigo)?						
Water/Air Pathway	26	156	1.3	1.5	0.3*,¶	--
Air-only Pathway	39	320	1.0	1.2	0.5	0.8
Comparison area	31	246				

Table 16.—Subjective, Continued.

Exposure Groups	Illness		Crude OR	Worry?		OR Adjusted for Worry
	Yes	No		Yes	No	
Watery, burning, or irritated eyes?						
Water/Air Pathway	42	134	2.6	2.5	2.8	2.6
Air-only Pathway	55	297	1.5	1.5	1.5	1.5
Comparison area	29	240				
Bleeding gums?						
Water/Air Pathway	14	167	1.7	3.5	1.1	2.1
Air-only Pathway	34	323	2.1	4.3	1.6	2.3
Comparison area	13	261				
Skin rashes?						
Water/Air Pathway	22	161	1.4	1.1	0.8	1.0
Air-only Pathway	37	326	1.1	0.9	1.3	1.0
Comparison area	25	248				
Chest pain? (15-75 yrs of age)						
Water/Air Pathway	31	135	1.6	1.4	1.4	1.4
Air-only Pathway	53	273	1.3	1.3	1.1	1.2
Comparison area	33	222				

* Only 1 observation in the "No" stratum

† p = 0.090 Breslow-Day test for eczema

§ p = 0.042 for Breslow-Day test for air-only pathway for drowsiness

¶ p = 0.096 for Breslow-Day test for water/air pathway for dizziness

Table 17.—Effect of Subjective Questions on reporting of current illness among participants ages 12 to 75 years.

Exposure groups	Current illness		Crude OR	Worry?		OR adjusted for worry
	Yes	No		Yes	No	
Frequent periods of anxiety, nervousness, or depression?						
Water/Air Pathway	14	170	1.5	1.1	1.4	1.2
Air-only Pathway	23	345	1.2	0.9	1.4	1.1
Comparison area	15	267				
Weakness or paralysis or numbness in arms or legs not due to stroke?						
Water/Air Pathway	9	175	1.3	0.8	NC*	0.7
Air-only Pathway	18	350	1.3	0.7	1.8	1.0
Comparison area	11	271				
High blood pressure (15-75 yrs of age)						
Water/Air Pathway	18	151	0.7	0.7	0.4	0.6
Air-only Pathway	57	283	1.2	1.1	0.9	1.0
Comparison area	38	224				
Heart attack, heart disease, or other heart problems? (15-75 yrs of age)						
Water/Air Pathway	16	153	1.5	1.8	0.5†	1.3
Air-only Pathway	35	305	1.7	1.6	1.9	1.7
Comparison area	17	245				

Table 17.—Subjective, Continued.

Exposure groups	Current Illness		Crude OR	Worry?		OR Adjusted for Worry
	Yes	No		Yes	No	
Asthma?						
Water/Air Pathway	16	168	1.0	0.7	2.5§	NC
Air-only Pathway	22	346	0.7	0.6	0.7	0.7
Comparison area	24	258				
Hayfever or other respiratory allergy (not asthma?)						
Water/Air Pathway	39	145	0.9	0.8	1.0	0.9
Air-only Pathway	81	287	1.0	0.8	1.1	1.0
Comparison area	63	219				
Bowel disease or intestinal problems?						
Water/Air Pathway	11	173	1.6	0.7	2.1	1.2
Air-only Pathway	10	358	0.7	0.6	0.3†	0.5
Comparison area	11	271				
Diabetes? (15-75 yrs of age)						
Water/Air Pathway	2	167	NC	NC	NC	NC
Air-only Pathway	14	326	1.1	0.9	1.6	1.2
Comparison area	10	252				
Arthritis, rheumatism or other joint disease?						
Water/Air Pathway	41	143	0.9	0.8	0.4‡	NA
Air-only Pathway	76	292	1.0	0.8	1.4	1.7
Comparison area	37	245				
Eczema or other skin problems?						
Water/Air Pathway	24	160	1.1	0.8	1.5	1.0
Air-only Pathway	29	339	0.6	0.5	0.6	0.6
Comparison area	34	248				

* NC, not calculated due to no observations in the "No" stratum

† only one observation in the "No" stratum

§ Breslow-Day test $p = 0.061$ for water asthma

‡ Breslow-Day test $p = 0.022$ for water-arthritis

Table 17.—Continued.

Exposure Groups	Current Symptom		Crude OR	Worry?		OR adjusted for worry
	Yes	No		Yes	No	
Tingling or prickling in fingers or toes?						
Water/Air Pathway	26	158	2.0	0.7	0.7	0.7
Air-only Pathway	57	311	1.7	0.8	1.0	0.8
Comparison area	43	238				
Numbness or the sensation of pins and needles in your fingers and toes?						
Water/Air Pathway	28	156	1.0	0.8	0.7	0.8
Air-only Pathway	61	307	1.1	0.8	1.4	1.0
Comparison area	42	240				
Severe and/or frequent headaches?						
Water/Air Pathway	28	156	1.5	1.0	1.1	1.0
Air-only Pathway	50	318	1.3	0.8	1.6	1.1
Comparison area	30	252				
Trouble sleeping?						
Water/Air Pathway	31	153	1.5	1.0	1.7	1.2
Air-only Pathway	51	317	1.2	0.9	1.0	1.0
Comparison area	33	249				
Frequent periods of drowsiness or fatigue?						
Water/Air Pathway	33	151	2.0	2.0	1.3	1.8
Air-only Pathway	58	310	1.7	1.9	1.0	1.4
Comparison area	28	254				
Dizziness or the sensation of moving while you are actually still (vertigo)?						
Water/Air Pathway	13	171	1.0	0.7	0.6*	0.7
Air-only Pathway	25	343	1.0	0.8	0.7	0.7
Comparison area	19	263				
Irritation or burning in your nose?						
Water/Air Pathway	9	175	1.2	2.0	2.5	0.8
Air-only Pathway	17	351	1.1	1.9	1.4	0.8
Comparison area	12	270				
Watery, burning, or irritated eyes?						
Water/Air Pathway	36	148	1.4	1.3	1.1	1.2
Air-only Pathway	66	302	1.3	1.2	1.1	1.2
Comparison area	41	241				

Table 17.—Subjective, Continued.

Exposure groups	Current Symptom		Crude OR	Worry?		OR adjusted for worry
	Yes	No		Yes	No	
Bleeding gums?						
Water/Air Pathway	9	175	1.2	2.6	†	NA
Air-only Pathway	28	340	1.9	3.7	1.2	1.9
Comparison area	12	270				
Skin rashes?						
Water/Air Pathway	14	170	0.9	1.1	0.6	0.9
Air-only Pathway	32	336	1.0	1.2	0.9	1.0
Comparison area	25	257				
Chest pain? (15-75 yrs of age)						
Water/Air Pathway	11	158	1.3	1.1	0.7*	1.0
Air-only Pathway	29	311	1.8	1.4	1.9	1.6
Comparison area	13	249				

* Only one observation in the "No" stratum.

† No observations in the "No" stratum, Breslow-Day $p = 0.079$.

Table 18.—Comparison of the number of child participants aged 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of illness since they moved to their current homes.

Exposure Groups	Illness		OR (90% CI)*
	Yes	No	
Frequent periods of anxiety, nervousness, or depression?			
Water/Air Pathway	3	28	NC†
Air-only Pathway	2	58	NC
Comparison area	1	44	
Seizures or epilepsy?			
Water/Air Pathway	0	31	NC
Air-only Pathway	3	58	NC
Comparison area	0	45	
Tremors or shakes?			
Water/Air Pathway	1	30	NC
Air-only Pathway	1	58	NC
Comparison area	0	43	
Neurologic or nervous system problems?			
Water/Air Pathway	1	30	NC
Air-only Pathway	8	58	3.0 (0.8-11.4)
Comparison area	2	43	1.0
Weakness or paralysis or numbness in arms or legs not due to stroke?			
Water/Air Pathway	1	30	NC
Air-only Pathway	2	59	NC
Comparison area	0	45	
Chronic bronchitis?			
Water/Air Pathway	0	30	NC
Air-only Pathway	2	59	NC
Comparison area	0	45	
Asthma?			
Water/Air Pathway	3	28	0.9 (0.2-3.1)
Air-only Pathway	4	57	0.6 (0.2-1.8)
Comparison area	5	40	1.0
Hayfever or other respiratory allergy (not asthma?)			
Water/Air Pathway	5	26	1.5 (0.5-4.7)
Air-only Pathway	9	52	1.4 (0.5-3.7)
Comparison area	5	40	1.0
Pneumonia?			
Water/Air Pathway	2	29	0.6 (0.1-2.3)
Air-only Pathway	4	57	0.6 (0.2-1.8)
Comparison area	5	40	1.0

Table 18.—Continued.

Exposure Groups	Illness		OR (90% CI)*
	Yes	No	
Bowel disease or intestinal problems?			
Water/Air Pathway	0	31	NC
Air-only Pathway	3	58	NC
Comparison area	0	45	
Thyroid disease?			
Water/Air Pathway	1	30	NC
Air-only Pathway	0	61	NC
Comparison area	0	45	
Anemia or other blood disorders (not cancer)?			
Water/Air Pathway	0	31	NC
Air-only Pathway	1	60	NC
Comparison area	2	43	
Cancers of the blood, leukemia, hodgekins disease, or lymphoma?			
Water/Air Pathway	0	31	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	
Other cancer or malignancy?*			
Water/Air Pathway	0	31	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	
Arthritis, rheumatism or other joint disease?			
Water/Air Pathway	0	31	NC
Air-only Pathway	1	60	NC
Comparison area	0	44	
Eczema or other skin problems?			
Water/Air Pathway	5	26	1.5 (0.5-4.7)
Air-only Pathway	7	54	1.0 (0.4-2.9)
Comparison area	5	40	1.0

* Odds ratio and Mantel Haenszel 90% confidence intervals. The comparison area is used as the referent group for each odds ratio.

† NC, OR not calculated when there are less than 2 cases in a group.

Table 19.—Comparison of the number of child participants aged 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who had first onset of symptoms since they moved to their current homes.

Exposure Groups	Symptom		OR (90% CI)*
	Yes	No	
Tingling or prickling in fingers or toes?			
Water/Air Pathway	1	27	NC
Air-only Pathway	8	50	NC
Comparison area	1	42	
Numbness or the sensation of pins and needles in your fingers and toes?			
Water/Air Pathway	3	26	NC
Air-only Pathway	6	48	NC
Comparison area	1	43	
Loss of consciousness or blackouts?			
Water/Air Pathway	1	30	NC
Air-only Pathway	4	57	1.5 (0.3-6.4)
Comparison area	2	42	
Severe and/or frequent headaches?			
Water/Air Pathway	7	24	1.2 (0.5-3.0)
Air-only Pathway	11	49	0.9 (0.4-2.1)
Comparison area	9	36	
Poor coordination?			
Water/Air Pathway	1	30	NC
Air-only Pathway	2	58	0.5 (0.1-2.2)
Comparison area	3	42	
Trouble sleeping?			
Water/Air Pathway	3	28	2.3 (0.5-10.6)
Air-only Pathway	5	54	2.0 (0.5-8.1)
Comparison area	2	43	
Frequent periods of drowsiness or fatigue?			
Water/Air Pathway	3	28	NC
Air-only Pathway	3	57	NC
Comparison area	0	45	
Dizziness or the sensation of moving while you are actually still (vertigo)?			
Water/Air Pathway	0	29	NC
Air-only Pathway	4	56	NC
Comparison area	1	44	
Irritation or burning in your nose?			
Water/Air Pathway	2	28	1.5 (0.3-8.4)
Air-only Pathway	1	60	NC
Comparison area	2	43	

Table 19.—Continued.

Exposure Groups	Symptom		OR (90% CI)*
	Yes	No	
Watery, burning, or irritated eyes?			
Water/Air Pathway	11	18	4.8 (1.7-13.5), p=0.01§
Air-only Pathway	8	49	1.3 (0.5-3.5)
Comparison area	5	39	1.0
Bleeding gums?			
Water/Air Pathway	5	26	NC
Air-only Pathway	4	55	NC
Comparison area	0	44	
Skin rashes?			
Water/Air Pathway	4	26	0.8 (0.3-2.6)
Air-only Pathway	10	50	1.1 (0.5-2.6)
Comparison area	7	38	1.0
Frequent periods of nausea or vomiting?			
Water/Air Pathway	2	29	1.0 (0.2-4.6)
Air-only Pathway	2	59	0.5 (0.1-2.2)
Comparison area	3	42	1.0

* Mantel Haenszel 90% confidence intervals. The comparison area is used as the referent group for each odds ratio.

† NC, OR not calculated when there are less than 2 cases in a group.

§ Calculated using exact methods using StatXact Software.

Table 20.—Comparison of the number of child participants ages 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently had an illness.

Exposure Groups	Current Illness		OR (90% CI)*
	Yes	No	
Frequent periods of anxiety, nervousness, or depression?			
Water/Air Pathway	1	30	NC†
Air-only Pathway	2	59	NC
Comparison area	1	44	
Seizures or epilepsy?			
Water/Air Pathway	0	31	NC
Air-only Pathway	2	59	NC
Comparison area	0	45	
Tremors or shakes?			
Water/Air Pathway	0	31	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	
Neurologic or nervous system problems?			
Water/Air Pathway	0	31	NC
Air-only Pathway	4	57	1.5 (0.4-6.5)
Comparison area	2	43	
Weakness or paralysis or numbness in arms or legs not due to stroke?			
Water/Air Pathway	1	30	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	
Chronic bronchitis?			
Water/Air Pathway	0	31	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	
Asthma?			
Water/Air Pathway	3	28	1.1 (0.3-4.1)
Air-only Pathway	5	56	0.9 (0.3-2.9)
Comparison area	4	41	1.0
Hayfever or other respiratory allergy (not asthma?)			
Water/Air Pathway	5	26	2.0 (0.6-6.4)
Air-only Pathway	7	54	1.3 (0.5-4.0)
Comparison area	4	41	1.0
Pneumonia?			
Water/Air Pathway	0	31	NC
Air-only Pathway	0	61	NC
Comparison area	0	45	

Table 20.—Continued.

Exposure Groups	Current Illness		OR (90% CI)*
	Yes	No	
Bowel disease or intestinal problems?			
Water/Air Pathway	1	30	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	
Thyroid disease?			
Water/Air Pathway	0	31	NC
Air-only Pathway	0	61	NC
Comparison area	0	45	
Anemia or other blood disorders (not cancer)?			
Water/Air Pathway	0	31	NC
Air-only Pathway	0	61	NC
Comparison area	1	45	
Cancers of the blood, leukemia, hodgkins disease, or lymphoma?			
Water/Air Pathway	0	31	NC
Air-only Pathway	0	61	NC
Comparison area	0	45	
Other cancer or malignancy?			
Water/Air Pathway	0	31	NC
Air-only Pathway	0	61	NC
Comparison area	0	45	
Arthritis, rheumatism or other joint disease?			
Water/Air Pathway	0	31	NC
Air-only Pathway	0	61	NC
Comparison area	0	45	
Eczema or other skin problems?			
Water/Air Pathway	7	24	3.0 (1.0-9.7)†
Air-only Pathway	5	56	0.9 (0.3-2.9)
Comparison area	4	41	1.0

* Odds ratio and Mantel Haenszel 90% confidence intervals. The comparison area is used as the referent group for each odds ratio.

† NC, not calculated if fewer than 2 cases were reported in any group.

‡ Calculated using exact methods.

Table 21.—Comparison of the number of child participants age 8 through 14 years from the target areas with potential water/air pathways (Ashumet Valley and Briarwood), the target areas with potential air-only pathways (Forestdale and Picture Lakes), and the comparison area who currently had a symptom.

Exposure Groups	Current symptom		OR (90% CI)*
	Yes	No	
Tingling or prickling in fingers or toes?			
Water/Air Pathway	3	28	1.5 (0.4-6.1)
Air-only Pathway	9	52	2.4 (0.8-7.5)
Comparison area	3	42	1.0
Numbness or the sensation of pins and needles in your fingers and toes?			
Water/Air Pathway	4	27	3.2 (0.8-13.3)
Air-only Pathway	9	52	3.7 (1.0-17.3)§
Comparison area	2	43	1.0
Loss of consciousness or blackouts?			
Water/Air Pathway	0	31	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	
Severe and/or frequent headaches?			
Water/Air Pathway	5	26	2.7 (0.8-9.3)
Air-only Pathway	10	51	2.8 (0.9-8.3)
Comparison area	3	42	1.0
Poor coordination?			
Water/Air Pathway	0	31	NC
Air-only Pathway	2	59	0.7 (0.1-3.9)
Comparison area	2	43	1.0
Trouble sleeping?			
Water/Air Pathway	2	29	NC
Air-only Pathway	6	55	NC
Comparison area	1	44	
Frequent periods of drowsiness or fatigue?			
Water/Air Pathway	3	28	NC
Air-only Pathway	3	58	NC
Comparison area	0	45	
Dizziness or the sensation of moving while you are actually still (vertigo)?			
Water/Air Pathway	0	31	NC
Air-only Pathway	3	58	NC
Comparison area	1	44	
Irritation or burning in your nose?			
Water/Air Pathway	2	29	NC
Air-only Pathway	1	60	NC
Comparison area	0	45	

Table 21.—Continued.

Exposure Groups	Current symptom		OR (90% CI)*
	Yes	No	
Watery, burning, or irritated eyes?			
Water/Air Pathway	11	20	3.6 (1.4-9.5), p=0.03§
Air-only Pathway	4	57	0.5 (0.2-1.4)
Comparison area	6	39	1.0
Bleeding gums?			
Water/Air Pathway	3	28	NC
Air-only Pathway	4	57	NC
Comparison area	1	44	1.0
Skin rashes?			
Water/Air Pathway	4	27	2.1 (0.6-7.7)
Air-only Pathway	5	56	1.3 (0.4-4.4)
Comparison area	3	42	1.0
Frequent periods of nausea or vomiting?			
Water/Air Pathway	1	30	NC
Air-only Pathway	3	58	1.1 (0.2-5.2)
Comparison area	2	43	1.0

* Mantel Haenszel 90% confidence intervals. The comparison area is used as the referent group for each odds ratio.

† NC, not calculated if fewer than 2 cases were reported in any group.

§ Calculated using mid-p adjustment to the exact confidence interval, StatXact software.

Table 22.—Comparison of the number of participants in each study area who had first onset of illness since moving to their current homes.

Exposure Groups	Illness		OR* (90% CI)	Was confounding assessed?†
	Yes	No		
Frequent periods of anxiety, nervousness, or depression?				
Ashumet Valley	16	86	2.2 (1.3-3.8), $p<0.05$	Yes
Briarwood	5	93	0.6 (0.3-1.4)	No
Forestdale	13	189	0.8 (0.5-1.5)	Yes
Picture Lakes	9	189	0.6 (0.3-1.1)	Yes
Comparison area	24	282	1.0	
Seizures or epilepsy?				
Ashumet Valley	0	102	NC	No
Briarwood	1	97	NC	No
Forestdale	0	202	NC	No
Picture Lakes	3	196	1.6 (0.4-5.9)	No
Comparison area	3	304	1.0	
Tremors or shakes?				
Ashumet Valley	1	101	NC	No
Briarwood	3	95	3.2 (0.9-11.6)	No
Forestdale	1	201	NC	No
Picture Lakes	2	197	1.0 (0.2-4.7)	No
Comparison area	3	304	1.0	
Neurologic or nervous system problems?				
Ashumet Valley	3	99	0.9 (0.3-2.7)	No
Briarwood	0	98	NC	No
Forestdale	7	195	1.1 (0.5-2.4)	No
Picture Lakes	6	193	0.9 (0.4-2.2)	No
Comparison area	10	296	1.0	
Weakness or paralysis or numbness in arms or legs not due to stroke?				
Ashumet Valley	2	100	0.5 (0.2-1.9)	No
Briarwood	4	93	1.2 (0.4-3.1)	No
Forestdale	6	196	0.8 (0.3-1.9)	No
Picture Lakes	9	189	1.3 (0.6-2.7)	Yes
Comparison area	11	296	1.0	
High blood pressure (15-75 yrs of age)				
Ashumet Valley	10	76	1.0 (0.5-1.9)	Yes
Briarwood	9	74	1.2 (0.6-2.6)§	Yes
Forestdale	21	150	1.1 (0.7-1.8)	Yes
Picture Lakes	33	136	1.9 (1.2-2.9), $p<0.05$	Yes
Comparison area	30	229	1.0	
Heart attack, heart disease, or other heart problems? (15-75 yrs of age)				
Ashumet Valley	8	78	2.0 (0.9-4.2)	No
Briarwood	6	76	1.5 (0.7-3.5)	No
Forestdale	13	158	1.6 (0.8-3.1)	Yes
Picture Lakes	10	158	1.2 (0.6-2.5)	Yes
Comparison area	13	249	1.0	
Chronic bronchitis?				
Ashumet Valley	5	96	2.6 (1.0-7.0)	No
Briarwood	1	97	NC	No
Forestdale	3	198	0.8 (0.2-2.4)	No
Picture Lakes	3	194	0.8 (0.2-2.5)	No
Comparison area	6	300	1.0	

Table 22.—Continued.

Exposure Groups	Illness		OR* (90% CI)	Was confounding assessed?
	Yes	No		
Asthma?				
Ashumet Valley	6	96	1.0 (0.4-2.1)	No
Briarwood	5	93	0.8 (0.4-1.9)	No
Forestdale	9	192	0.7 (0.4-1.4)	Yes
Picture Lakes	8	191	0.6 (0.3-1.3)	Yes
Comparison area	19	288	1.0	
Hayfever or other respiratory allergy (not asthma?)				
Ashumet Valley	17	83	2.2 (1.2-4.1), $p<0.05$	Yes
Briarwood	9	88	2.1 (0.9-4.6)**	Yes
Forestdale	19	178	1.5 (0.9-2.6)	Yes
Picture Lakes	19	179	1.5 (0.9-2.6)	Yes
Comparison area	20	279	1.0	
Pneumonia?				
Ashumet Valley	14	88	2.4 (1.3-4.4), $p<0.05$	Yes
Briarwood	11	85	2.0 (1.0-3.7), $p<0.10$	Yes
Forestdale	12	188	1.0 (0.5-1.8)	Yes
Picture Lakes	14	185	1.1 (0.6-2.1)	Yes
Comparison area	19	286	1.0	
Emphysema? (15-75 years)				
Ashumet Valley	0	86	NC	No
Briarwood	0	83	NC	No
Forestdale	3	168	1.5 (0.4-5.9)	No
Picture Lakes	3	166	1.6 (0.4-6.0)	No
Comparison area	3	259	1.0	
Ulcers or other stomach disease? (15-75 yrs of age)				
Ashumet Valley	3	83	2.3 (0.7-8.1)	No
Briarwood	3	80	2.4 (0.7-8.3)	No
Forestdale	4	167	1.6 (0.5-5.0)	No
Picture Lakes	10	158	4.1 (1.6-10.2), $p<0.05$	No
Comparison area	4	258	1.0	
Bowel disease or intestinal problems?				
Ashumet Valley	7	95	2.2 (1.0-4.9)	No
Briarwood	3	95	0.9 (0.3-2.8)	No
Forestdale	9	192	1.4 (0.6-3.0)	Yes
Picture Lakes	7	192	1.1 (0.5-2.5)	No
Comparison area	10	296	1.0	
Gallstones or other gallbladder disease? (15-75 yrs of age)				
Ashumet Valley	3	83	1.1 (0.4-3.6)	No
Briarwood	1	82	NC	No
Forestdale	5	166	1.0 (0.4-2.5)	No
Picture Lakes	7	162	1.4 (0.6-3.3)	No
Comparison area	8	253	1.0	
Kidney disease? (15-75 yrs of age)				
Ashumet Valley	1	85	NC	No
Briarwood	1	82	NC	No
Forestdale	2	169	1.5 (0.3-8.0)	No
Picture Lakes	1	167	NC	No
Comparison area	2	260	1.0	

Table 22.—Continued.

Exposure Groups	Illness		OR* (90% CI)	Was confounding assessed?
	Yes	No		
Other urinary tract disease, including prostate trouble? (15-75 yrs of age)				
Ashumet Valley	11	74	2.3 (1.2-4.4), $p<0.05$	Yes
Briarwood	6	77	1.2 (0.5-2.7)	No
Forestdale	12	159	1.1 (0.6-2.2)	Yes
Picture Lakes	10	158	1.0 (0.5-1.9)	Yes
Comparison area	16	242	1.0	
Diabetes? (15-75 yrs of age)				
Ashumet Valley	1	85	NC	No
Briarwood	0	83	NC	No
Forestdale	3	168	0.5 (0.2-1.3)	No
Picture Lakes	7	162	1.1 (0.5-2.5)	No
Comparison area	10	252	1.0	
Thyroid disease?				
Ashumet Valley	5	97	3.1 (1.1-8.5), $p<0.10$	No
Briarwood	2	96	1.3 (0.3-5.0)	No
Forestdale	4	198	1.2 (0.4-3.7)	No
Picture Lakes	5	193	1.6 (0.6-4.5)	No
Comparison area	5	302	1.0	
Anemia or other blood disorders (not cancer)?				
Ashumet Valley	10	91	2.1 (1.1-4.2), $p<0.10$	Yes
Briarwood	6	92	1.3 (0.6-2.8)	No
Forestdale	7	194	0.7 (0.3-1.5)	No
Picture Lakes	7	192	0.7 (0.3-1.5)	No
Comparison area	15	288	1.0	
Cancers of the blood, leukemia, hodgkins disease, or lymphoma?				
Ashumet Valley	3	99	2.3 (0.7-7.9)	No
Briarwood	1	97	NC	No
Forestdale	1	201	NC	No
Picture Lakes	1	198	NC	No
Comparison area	4	303	1.0	
Other cancer or malignancy?				
Ashumet Valley	6	96	1.9 (0.7-5.2)	No
Briarwood	3	95	0.9 (0.3-3.5)	No
Forestdale	4	198	0.6 (0.2-1.9)	No
Picture Lakes	5	194	0.8 (0.3-2.3)	No
Comparison area	10	297	1.0	
Arthritis, rheumatism or other joint disease?				
Ashumet Valley	15	86	1.8 (1.0-3.2)††, $p<0.10$	Yes
Briarwood	7	91	0.6 (0.3-1.2)	No
Forestdale	29	170	1.7 (1.0-2.8), $p<0.10$ §§	Yes
Picture Lakes	29	170	1.2 (0.7-1.9)¶¶	Yes
Comparison area	35	271	1.0	
Eczema or other skin problems?				
Ashumet Valley	9	93	1.1 (0.6-2.2)	Yes
Briarwood	8	89	1.1 (0.5-2.1)	No
Forestdale	14	184	0.9 (0.5-1.6)	Yes
Picture Lakes	11	184	0.6 (0.3-1.1)***	Yes
Comparison area	24	280	1.0	

* The comparison area is used as the referent group for each odds ratio.

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

† When sample size was sufficient, the data were modelled using logistic regression to assess confounding. When crude results did not differ from logistic regression results, the crude results are presented.

§ Model for high blood pressure in Briarwood adjusting for age and years living in home.

¶ Model for hayfever in Ashumet Valley adjusting for age and years living in current home.

** Model for hayfever in Briarwood adjusting for age and years living in current home.

†† Model for arthritis in Ashumet Valley adjusting for age and income.

§§ Model for arthritis in Forestdale adjusting for age, income, year of study, and years living in home.

¶¶ Model for arthritis in Picture Lakes adjusting for age, years living in home, current alcohol consumption.

*** Model for eczema in Picture Lakes adjusting for alcohol and year of study.

Table 23.—Comparison of the number of participants in each study area who had first onset of symptoms since they moved to their homes.

Exposure Groups	Symptom		OR* (90% CI)	Was confounding assessed?
	Yes	No		
Tingling or prickling in fingers or toes?				
Ashumet Valley	11	84	0.8 (0.4-1.4)	Yes
Briarwood	17	77	1.3 (0.8-2.1)	Yes
Forestdale	36	158	1.3 (0.9-2.0)	Yes
Picture Lakes	28	164	1.0 (0.6-1.5)	Yes
Comparison area	43	247	1.0	
Numbness or the sensation of pins and needles in your fingers and toes?				
Ashumet Valley	16	79	1.5 (0.9-2.6)	Yes
Briarwood	18	78	2.2 (1.2-3.7), $p<0.05$ §	Yes
Forestdale	30	160	1.4 (0.9-2.1)	Yes
Picture Lakes	28	162	1.3 (0.8-2.0)	Yes
Comparison area	34	249	1.0	
Loss of consciousness or blackouts?				
Ashumet Valley	7	95	2.0 (0.9-4.4)	No
Briarwood	2	96	0.6 (0.2-2.0)	No
Forestdale	10	191	1.4 (0.7-2.9)	Yes
Picture Lakes	8	190	1.1 (0.5-2.5)	Yes
Comparison area	11	293	1.0	
Severe and/or frequent headaches?				
Ashumet Valley	19	80	1.6 (1.0-2.6)	Yes
Briarwood	14	83	1.3 (0.7-2.3)¶	Yes
Forestdale	33	165	1.3 (0.9-2.0)	Yes
Picture Lakes	23	171	0.9 (0.6-1.4)	Yes
Comparison area	40	264	1.0	
Poor coordination?				
Ashumet Valley	2	99	1.0 (0.3-3.9)	No
Briarwood	2	96	1.0 (0.3-4.0)	No
Forestdale	5	197	1.3 (0.5-3.5)	No
Picture Lakes	8	190	2.1 (0.9-5.1)	No
Comparison area	6	299	1.0	
Trouble sleeping?				
Ashumet Valley	11	88	1.2 (0.6-2.2)	Yes
Briarwood	11	86	1.2 (0.7-2.2)	Yes
Forestdale	20	178	1.1 (0.6-1.7)	Yes
Picture Lakes	25	168	1.4 (0.9-2.3)	Yes
Comparison area	29	271	1.0	
Frequent periods of drowsiness or fatigue?				
Ashumet Valley	17	84	2.0 (1.2-3.4), $p<0.05$	Yes
Briarwood	16	80	2.0 (1.1-3.4), $p<0.05$	Yes
Forestdale	29	169	1.7 (1.1-2.7), $p<0.10$	Yes
Picture Lakes	35	160	1.8 (1.1-2.9), $p<0.05$,**	Yes
Comparison area	28	274	1.0	

Table 23.—Continued.

Exposure Groups	Symptom		OR* (90% CI)	Was confounding assessed?
	Yes	No		
Dizziness or the sensation of moving while you are actually still?				
Ashumet Valley	9	91	0.9 (0.5-1.7)	Yes
Briarwood	17	80	1.9 (1.1-3.2), p<0.10	Yes
Forestdale	17	179	0.8 (0.5-1.4)	Yes
Picture Lakes	22	173	1.1 (0.7-1.8)	Yes
Comparison area	31	271	1.0	
Irritation or burning in your nose?				
Ashumet Valley	3	96	1.3 (0.4-4.2)	No
Briarwood	8	89	3.8 (1.7-8.6), p<0.01	No
Forestdale	7	191	1.6 (0.6-3.8)	No
Picture Lakes	7	189	1.6 (0.6-3.8)	No
Comparison area	7	295	1.0	
Watery, burning, or irritated eyes?				
Ashumet Valley	26	71	3.1 (1.9-5.0), p<0.01	Yes
Briarwood	22	71	2.6 (1.6-4.3), p<0.01	Yes
Forestdale	25	167	1.3 (0.8-2.0)	Yes
Picture Lakes	31	161	1.6 (1.1-2.6), p<0.10	Yes
Comparison area	31	263	1.0	
Bleeding gums?				
Ashumet Valley	11	90	2.7 (1.4-5.3), p<0.05	Yes
Briarwood	6	90	1.5 (0.6-3.4)	No
Forestdale	15	180	1.8 (1.0-3.5)	Yes
Picture Lakes	20	175	2.5 (1.4-4.5), p<0.05	Yes
Comparison area	13	286	1.0	
Skin rashes?				
Ashumet Valley	13	88	1.4 (0.8-2.5)	Yes
Briarwood	12	85	1.3 (0.7-2.4)	Yes
Forestdale	21	179	1.1 (0.7-1.8)	Yes
Picture Lakes	22	174	1.2 (0.7-1.9)	Yes
Comparison area	29	269	1.0	
Frequent periods of nausea or vomiting?				
Ashumet Valley	5	97	1.5 (0.6-3.8)	No
Briarwood	3	95	0.9 (0.3-2.8)	No
Forestdale	6	196	0.9 (0.4-2.2)	No
Picture Lakes	5	194	0.8 (0.3-1.9)	No
Comparison area	10	296	1.0	
Chest pain? (15-75 yrs of age)				
Ashumet Valley	18	67	1.8 (1.1-3.1), p<0.10	Yes
Briarwood	13	68	1.3 (0.7-2.3)	Yes
Forestdale	21	141	1.2 (0.7-1.8)	Yes
Picture Lakes	29	132	1.5 (0.9-2.3)	Yes
Comparison area	33	222	1.0	

* The comparison area is used as the referent group for each odds ratio.

† When sample size was sufficient, the data were modelled using logistic regression to assess confounding. When crude results did not differ from logistic regression results, the crude results are presented.

§ Model for numbness in Briarwood adjusting for years living in current home.

¶ Model for headaches in Briarwood adjusting for age, sex, years living in current home.

** Model for drowsiness in Picture Lakes adjusting for age, alcohol and year of study.

Table 24.—Comparison of the number of participants in each study area who currently had illness.

Exposure Groups	Current Illness		OR* (90% CI)
	Yes	No	
Frequent periods of anxiety, nervousness, or depression?			
Ashumet Valley	9	93	1.8 (0.9-3.6)
Briarwood	6	92	1.2 (0.5-2.7)
Forestdale	13	189	1.3 (0.7-2.4)
Picture Lakes	11	188	1.1 (0.6-2.1)
Comparison area	16	291	1.0
Seizures or epilepsy?			
Ashumet Valley	0	102	NC†
Briarwood	0	98	NC
Forestdale	0	202	NC
Picture Lakes	3	196	2.3 (0.5-10.1)
Comparison area	2	305	1.0
Tremors or shakes?			
Ashumet Valley	2	100	1.2 (0.3-4.9)
Briarwood	2	96	1.3 (0.3-5.0)
Forestdale	1	201	NC
Picture Lakes	2	197	0.6 (0.2-2.4)
Comparison area	5	302	1.0
Neurologic or nervous system problems?			
Ashumet Valley	3	99	1.1 (0.37-3.51)
Briarwood	0	98	NC
Forestdale	10	192	2.0 (0.9-4.3)
Picture Lakes	8	191	1.6 (0.7-3.6)
Comparison area	8	299	1.0
Weakness or paralysis or numbness in arms or legs not due to stroke?			
Ashumet Valley	3	99	0.8 (0.3-2.4)
Briarwood	7	91	2.1 (0.9-4.6)
Forestdale	7	195	1.0 (0.4-2.2)
Picture Lakes	11	188	1.6 (0.8-3.2)
Comparison area	11	296	1.0
High blood pressure (15-75 yrs of age)			
Ashumet Valley	9	77	0.7 (0.4-1.3)
Briarwood	9	74	0.7 (0.4-1.4)
Forestdale	23	148	0.9 (0.6-1.5)
Picture Lakes	34	135	1.5 (1.0-2.3)
Comparison area	38	224	1.0
Heart attack, heart disease, or other heart problems? (15-75 yrs of age)			
Ashumet Valley	8	78	1.5 (0.7-3.1)
Briarwood	8	75	1.5 (0.7-3.2)
Forestdale	13	158	1.2 (0.6-2.2)
Picture Lakes	22	147	2.2 (1.3-3.7), p<0.05
Comparison area	17	245	1.0
Chronic bronchitis?			
Ashumet Valley	8	94	4.3 (1.8-9.9), p<0.01
Briarwood	4	94	2.1 (0.7-6.1)
Forestdale	3	199	0.8 (0.3-2.4)
Picture Lakes	9	190	2.4 (1.0-5.6), p<0.10
Comparison area	6	301	1.0

Table 24.—Continued.

Exposure Groups	Current Illness		OR* (90% CI)
	Yes	No	
Asthma?			
Ashumet Valley	11	91	1.3 (0.7-2.4)
Briarwood	6	92	0.7 (0.3-1.5)
Forestdale	15	187	0.9 (0.5-1.5)
Picture Lakes	9	190	0.5 (0.3-1.0), p<0.10
Comparison area	26	281	1.0
Hayfever or other respiratory allergy (not asthma?)			
Ashumet Valley	26	76	1.3 (0.8-2.0)
Briarwood	15	83	0.7 (0.4-1.1)
Forestdale	46	156	1.1 (0.8-1.6)
Picture Lakes	39	160	0.9 (0.6-1.3)
Comparison area	65	242	1.0
Pneumonia?			
Ashumet Valley	0	102	NC
Briarwood	2	96	NC
Forestdale	0	202	NC
Picture Lakes	1	198	NC
Comparison area	0	307	1.0
Emphysema? (15-75 years)			
Ashumet Valley	0	86	NC
Briarwood	0	83	NC
Forestdale	2	169	0.8 (0.2-3.2)
Picture Lakes	3	166	1.2 (0.3-4.1)
Comparison area	4	258	1.0
Ulcers or other stomach disease? (15-75 yrs of age)			
Ashumet Valley	4	82	2.5 (0.8-7.5)
Briarwood	4	79	2.6 (0.9-7.7)
Forestdale	4	167	1.2 (0.4-3.8)
Picture Lakes	8	161	2.6 (1.0-6.4), p<0.10
Comparison area	5	257	1.0
Bowel disease or intestinal problems?			
Ashumet Valley	7	95	2.0 (0.9-4.4)
Briarwood	5	93	1.5 (0.6-3.6)
Forestdale	5	197	0.7 (0.3-1.7)
Picture Lakes	5	194	0.7 (0.3-1.7)
Comparison area	11	296	1.0
Gallstones or other gallbladder disease? (15-75 yrs of age)			
Ashumet Valley	0	86	NC
Briarwood	0	83	NC
Forestdale	1	170	NC
Picture Lakes	5	164	NC
Comparison area	1	261	1.0
Kidney disease? (15-75 yrs of age)			
Ashumet Valley	1	85	NC
Briarwood	0	83	NC
Forestdale	2	169	NC
Picture Lakes	2	167	NC
Comparison area	1	261	1.0

Table 24.—Continued.

Exposure Groups	Current Illness		OR* (90% CI)
	Yes	No	
Other urinary tract disease, including prostate trouble? (15-75 yrs of age)			
Ashumet Valley	3	83	1.5 (0.5-5.0)
Briarwood	4	79	2.2 (0.8-6.2)
Forestdale	2	169	0.5 (0.1-1.9)
Picture Lakes	4	165	1.0 (0.4-3.0)
Comparison area	6	256	1.0
Diabetes? (15-75 yrs of age)			
Ashumet Valley	1	85	NC
Briarwood	1	82	NC
Forestdale	5	166	0.8 (0.3-1.9)
Picture Lakes	9	160	1.4 (0.7-3.1)
Comparison area	10	252	1.0
Thyroid disease?			
Ashumet Valley	3	99	1.1 (0.4-3.5)
Briarwood	4	94	1.6 (0.6-4.4)
Forestdale	7	195	1.3 (0.6-3.2)
Picture Lakes	9	190	1.8 (0.8-4.0)
Comparison area	8	299	1.0
Anemia or other blood disorders (not cancer)?			
Ashumet Valley	5	97	1.5 (0.6-3.8)
Briarwood	3	95	0.9 (0.3-2.8)
Forestdale	4	198	0.6 (0.2-1.6)
Picture Lakes	4	195	0.6 (0.2-1.6)
Comparison area	10	297	1.0
Cancers of the blood, leukemia, hodgkins disease, or lymphoma?			
Ashumet Valley	0	102	NC
Briarwood	0	98	NC
Forestdale	0	202	NC
Picture Lakes	2	197	1.0 (0.2-4.7)
Comparison area	3	304	1.0
Other cancer or malignancy?			
Ashumet Valley	1	101	NC
Briarwood	1	97	NC
Forestdale	1	201	NC
Picture Lakes	5	194	NC
Comparison area	1	306	1.0
Arthritis, rheumatism or other joint disease?			
Ashumet Valley	22	80	2.0 (1.2-3.3), p<0.05
Briarwood	19	79	1.8 (1.1-2.9), p<0.10
Forestdale	37	165	1.6 (1.1-2.5), p<0.10
Picture Lakes	39	160	1.8 (1.2-2.7), p<0.05
Comparison area	37	270	1.0
Eczema or other skin problems?			
Ashumet Valley	15	87	1.3 (0.8-2.3)
Briarwood	12	86	1.1 (0.6-2.0)
Forestdale	16	186	0.7 (0.4-1.1)
Picture Lakes	15	184	0.6 (0.4-1.1)
Comparison area	35	272	1.0

* The comparison area is used as the referent group for each odds ratio. When sample size was sufficiently frequent, the data were modelled using logistic regression. In all cases, the crude results did not differ from logistic regression results and therefore the crude results are presented.

† NC, not calculated when fewer than 2 cases were in any group.

Table 25.—Comparison of the number of participant in each study area who currently have symptoms.

Exposure Groups	Current Symptom		OR* (90% CI)
	Yes	No	
Tingling or prickling in fingers or toes?			
Ashumet Valley	11	91	0.7 (0.4-1.3)
Briarwood	16	82	1.2 (0.7-2.0)
Forestdale	30	172	1.1 (0.7-1.6)
Picture Lakes	29	170	1.0 (0.7-1.6)
Comparison area	43	264	1.0
Numbness or the sensation of pins and needles in your fingers and toes?			
Ashumet Valley	15	87	1.1 (0.6-1.9)
Briarwood	15	83	1.1 (0.7-2.0)
Forestdale	30	172	1.1 (0.72-1.68)
Picture Lakes	32	167	1.2 (0.80-1.84)
Comparison area	42	265	1.0
Loss of consciousness or blackouts?			
Ashumet Valley	1	101	NC
Briarwood	1	97	NC
Forestdale	3	199	NC
Picture Lakes	0	199	NC
Comparison area	1	306	1.0
Severe and/or frequent headaches?			
Ashumet Valley	21	81	2.2 (1.3-3.5), $p<0.05$
Briarwood	9	89	0.8 (0.4-1.6)
Forestdale	29	173	1.4 (0.9-2.2)
Picture Lakes	27	172	1.3 (0.8-2.1)
Comparison area	33	274	1.0
Poor coordination?			
Ashumet Valley	3	99	1.1 (0.4-3.5)
Briarwood	2	96	0.8 (0.2-2.9)
Forestdale	7	195	1.3 (0.6-3.2)
Picture Lakes	6	193	1.2 (0.5-2.9)
Comparison area	8	299	1.0
Trouble sleeping?			
Ashumet Valley	18	84	1.8 (1.1-3.0), $p<0.10$
Briarwood	14	84	1.4 (0.8-2.4)
Forestdale	22	180	1.0 (0.6-1.6)
Picture Lakes	31	168	1.5 (1.0-2.4)
Comparison area	33	274	1.0
Frequent periods of drowsiness or fatigue?			
Ashumet Valley	15	87	1.7 (1.0-3.0)
Briarwood	19	79	2.4 (1.4-4.0), $p<0.01$
Forestdale	26	176	1.5 (0.9-2.4)
Picture Lakes	34	165	2.1 (1.3-3.2), $p<0.01$
Comparison area	28	279	1.0

Table 25.—Continued.

Exposure Groups	current symptom		OR* (90% CI)
	Yes	No	
Dizziness or the sensation of moving while you are actually still?			
Ashumet Valley	4	98	0.6 (0.3-1.6)
Briarwood	9	89	1.5 (0.8-3.1)
Forestdale	15	187	1.2 (0.7-2.2)
Picture Lakes	11	188	0.9 (0.5-1.7)
Comparison area	19	288	1.0
Irritation or burning in your nose?			
Ashumet Valley	3	99	0.8 (0.3-2.2)
Briarwood	7	91	1.9 (0.9-4.2)
Forestdale	8	194	1.0 (0.5-2.2)
Picture Lakes	10	189	1.3 (0.6-2.7)
Comparison area	12	295	1.0
Watery, burning, or irritated eyes?			
Ashumet Valley	22	80	1.7 (1.1-2.8), $p<0.10$
Briarwood	22	76	1.8 (1.1-3.0), $p<0.05$
Forestdale	36	166	1.4 (0.9-2.1)
Picture Lakes	31	168	1.2 (0.8-1.8)
Comparison area	42	265	1.0
Bleeding gums?			
Ashumet Valley	8	94	2.1 (1.0-4.5)
Briarwood	4	94	1.1 (0.4-2.8)
Forestdale	16	186	2.1 (1.1-4.0), $p<0.10$
Picture Lakes	13	186	1.7 (0.9-3.4)
Comparison area	12	295	1.0
Skin rashes?			
Ashumet Valley	10	92	1.2 (0.6-2.2)
Briarwood	6	92	0.7 (0.3-1.5)
Forestdale	18	184	1.1 (0.6-1.8)
Picture Lakes	18	181	1.1 (0.6-1.8)
Comparison area	26	281	1.0
Frequent periods of nausea or vomiting?			
Ashumet Valley	1	101	NC
Briarwood	1	97	NC
Forestdale	6	196	2.3 (0.8-6.6)
Picture Lakes	4	195	1.6 (0.5-5.0)
Comparison area	4	303	1.0
Chest pain? (15-75 yrs of age)			
Ashumet Valley	5	81	1.2 (0.5-2.9)
Briarwood	6	77	1.5 (0.7-3.4)
Forestdale	10	161	1.2 (0.6-2.4)
Picture Lakes	19	150	2.4 (1.3-4.4), $p<0.05$
Comparison area	13	249	1.0

* The comparison area is used as the referent group for each odds ratio. When sample size was sufficient, the data were modelled using logistic regression to assess confounding. Crude results did not differ from logistic regression results and therefore the crude results are presented.

Table 26.—Summary of illnesses with elevated* or decreased† odds ratios for each target area versus comparison area, by definition of illness.

Illness	Odds Ratios comparing reporting of illness among target area participants to illness among comparison area participants.							
	Illness with first onset since participant moved to current home				Current illness			
	Ashumet Valley	Briarwood	Forestdale	Picture Lakes	Ashumet Valley	Briarwood	Forestdale	Picture Lakes
Anxiety, nervousness, or depression	2.2§							
Seizures or epilepsy								2.3
Tremors or shakes		3.2						
Nervous system disease							2.0	
Weakness, numbness	0.5					2.1		
High blood pressure				1.9§				
Heart disease	2.0							2.2§
Chronic bronchitis	2.6				4.3§	2.1		2.4§
Asthma								0.5§
Hayfever or respiratory allergy	2.2§	2.1						
Pneumonia	2.4§	2.0§						
Emphysema								
Ulcers or stomach disease	2.3	2.4		4.1§	2.5	2.6		2.6§
Bowel or intestinal problems	2.2				2.0			
Gallstones								
Kidney disease								
Urinary tract disease	2.3					2.2	0.5	
Diabetes			0.5					
Thyroid disease	3.1§							
Anemia or blood disorders	2.1§							
Cancer of blood	2.3							
Other cancer								
Arthritis/joint disease	1.8§		1.7§		2.0§	1.8§	1.6§	1.8§
Eczema								

* An elevated odds ratio (OR) is defined as (1) an OR > 1.0 and p < 0.10 or (2) OR ≥ 2.0.

† A decreased OR is defined as (1) an OR < 1.0 and p < 0.10 or (2) OR ≤ 0.5.

§ p < 0.05.

Table 27.—Summary of symptoms with elevated* or decreased† ORs for each target area versus comparison area, by definition of symptom.

Symptom	Symptoms with first onset since participant moved to current residence				Current symptom			
	Ashumet Valley	Briarwood	Forestdale	Picture Lakes	Ashumet Valley	Briarwood	Forestdale	Picture Lakes
Tingling								
Numbness		2.2§						
Blackouts	2.0							
Headaches					2.2§			
Poor coordination				2.1				
Trouble sleeping					1.8§			
Frequent drowsiness/fatigue	2.0§	2.6§	1.7§	1.6§		2.4§		2.1§
Dizziness		1.9§						
Irritated nose		3.8§						
Watery, burning eyes	3.1§	2.6§		1.6§	1.7§	1.8§		
bleeding gums	2.7§			2.5§	2.1		2.1§	
rashes								
Chest pain	1.8§							2.4§
Nausea							2.3	

* An elevated odds ratio (OR) is defined as (1) an OR > 1.0 and p < 0.10 or (2) OR ≥ 2.0.

† A decreased OR is defined as (1) an OR < 1.0 and p < 0.10 or (2) OR ≤ 0.5.

§ p < 0.10

Table 28.—Comparison of the effect of dropping persons who reported never using well water from analysis of illnesses with first onset since moving to the current home: Odds ratios for target area participants versus comparison area and odds ratios for target area participants who used well water versus comparison area.

Condition	Ashumet Valley and Briarwood Combined		Ashumet Valley		Briarwood	
	All	Well Water Users Only	All	Well Water Users Only	All	Well Water Users Only
Anxiety	1.4	1.3	2.2*	2.3*	0.6	0.7
Seizures	NC†	NC	NC	NC	NC	NC
Tremors	2.1	1.4	NC	NC	3.2	3.7*
Neurologic	0.5	0.5	0.9	1.0	NC	NC
Weakness	0.9	1.3	0.5	0.6	1.2	1.3
High blood pressure	0.9	1.3	0.9	0.6	1.2	1.2
Heart disease	1.7	2.3*	2.0	2.2*	1.5	1.4
Chronic bronchitis	1.6	1.5	2.6	2.3	NC	NC
Asthma	0.9	0.5	1.0	0.9	0.6	0.7
Hayfever	2.1*	2.2*	2.2*	2.4*	2.1	1.8
Pneumonia	2.1*	2.3*	2.4*	2.3*	2.0*	2.3*
Emphysema	NC	NC	NC	NC	NC	NC
Ulcers or stomach disease	2.4	2.2	2.3	2.6	2.4	1.8
Bowel disease	1.6	1.4	2.2	1.0	0.9	1.1
Gallstones	0.8	0.9	1.1	1.3	NC	NC
Kidney disease	1.6	1.7	NC	NC	NC	NC
Urinary tract disease	1.7	1.8	2.3*	2.3*	1.2	1.4
Diabetes	NC	NC	NC	NC	NC	NC
Thyroid disease	2.2	2.5	3.1*	3.5*	1.3	1.4
Anemia	1.7	1.9*	2.1*	2.4*	1.3	1.4
Cancer of blood	1.6	2.3*	2.3	2.6	NC	NC
Other cancer	1.4	1.3	1.9	1.8	0.9	0.7
Arthritis	1.0	1.0	1.8*	1.6	0.6	0.7
Eczema	1.1	1.3	1.1	1.3	1.1	1.2

* Statistically significant at $p < 0.10$.

† NC, not calculated because a cell had fewer than 2 observations.

Table 29.—Comparison of the effect of dropping persons who reported never using well water from analysis of symptoms with first onset since moving to the current home: Odds ratios for target area participants versus comparison area and odds ratios for target area participants who used well water versus comparison area.

Symptoms	Ashumet Valley and Briarwood Combined		Ashumet Valley		Briarwood	
	All	Well Water Users Only	All	Well Water Users Only	All	Well Water Users Only
Tingling	1.0	1.1	0.9	0.7	1.3	1.5
Numbness	1.6*	1.7*	1.5	1.6	2.2*	2.2*
Blackouts	1.3	1.1	2.0	1.9	0.6	NC
Headaches	1.3	1.4	1.0	1.6	1.3	1.3
Poor coordination	1.0	1.2	1.0	1.1	1.0	1.2
Trouble sleeping	1.2	1.2	1.2	1.1	1.2	1.3
Frequent drowsiness or fatigue	2.0*	2.1*	2.0*	2.1*	2.0*	2.1*
Dizziness	1.3	1.4	0.9	0.9	1.9*	2.0*
Irritated nose	2.5*	2.9*	1.3	0.9	3.8*	4.4*
Water, burning eyes	2.9*	3.2*	3.1*	3.5*	2.6*	3.0*
Bleeding gums	2.1*	2.1*	2.7*	2.7*	1.5	1.3
Rashes	1.3	1.4	1.4	1.4	1.3	1.4
Frequent nausea	1.2	1.0	1.5	1.0	0.9	1.1
Chest Pain	1.5	1.7*	1.8*	1.9*	1.3	1.5

* Statistically significant at $p < 0.10$.

† NC, not calculated because a cell had fewer than 2 observations.

Table 30.—Comparison of the effect of dropping persons who reported never using well water from analysis of current illnesses: Odds ratios for target area participants versus comparison area and odds ratios for target area participants who used well water versus comparison area.

Current illness	Ashumet Valley and Briarwood Combined		Ashumet Valley		Briarwood	
	All	Well Water Users Only	All	Well Water Users Only	All	Well Water Users Only
Anxiety	1.5	1.7	1.3	2.0	1.2	1.4
Seizures	NC†	NC	NC	NC	NC	NC
Tremors	1.3	1.4	4.3*	1.6	1.3	1.4
Neurologic	0.6	0.6	1.1	1.3	NC	NC
Weakness	1.4	1.3	0.3	0.6	2.1	2.0
High blood pressure	0.7	0.7	0.7	2.0	0.7	0.7
Heart disease	1.5	1.6	1.5	1.7	1.5	1.5
Chronic bronchitis	3.2*	3.0*	4.3*	4.2*	2.1*	1.8
Asthma	1.0	0.7	1.3	0.6	0.7	0.5
Hayfever	0.6	1.7	1.3	1.4	0.7	0.7
Pneumonia	NC	NC	NC	NC	NC	NC
Emphysema	NC	NC	NC	NC	NC	NC
Ulcers/stomach disease	2.6*	2.9*	2.5*	2.8*	2.6	2.9
Bowel disease	1.7	1.6	2.0	1.6	1.5	1.7
Gallstones	NC	NC	NC	NC	NC	NC
kidney disease	NC	NC	NC	NC	NC	NC
Urinary tract disease	1.8	2.1	1.5	1.7	2.2	2.9
Diabetes	0.3	0.3	NC	NC	NC	NC
Thyroid disease	0.3	1.3	1.1	0.8	1.6	1.8
Anemia	1.2	1.4	1.5	1.4	0.9	1.1
Cancer of blood	NC	NC	NC	NC	NC	NC
Other cancer	NC	NC	NC	NC	NC	NC
Arthritis	1.9*	1.9*	2.0*	1.9*	1.8*	1.8*
Eczema	1.2	1.3	1.3	1.4	1.1	1.3

* Statistically significant at $p < 0.10$.

† NC, not calculated because a cell had fewer than 2 observations.

Table 31.—Comparison of the effect of dropping persons who reported never using well water from analysis of current symptoms.

Current Symptoms	Ashumet Valley and Briarwood Combined		Ashumet Valley		Briarwood	
	All	Well Water Users Only	All	Well Water Users Only	All	Well Water Users Only
Tingling	1.0	1.5	0.7	0.8	1.2	1.2
Numbness	1.11	1.1	1.1	1.1	1.1	1.1
Blackouts	NC†	NC	NC	NC	NC	NC
Headaches	1.5	1.5	2.2*	2.2*	0.8	0.9
Poor coordination	1.0	1.1	1.1	1.3	0.8	0.9
Trouble sleeping	1.6*	1.6*	1.8*	1.8*	1.4	1.5
Frequent drowsiness or fatigue	2.0*	2.1*	1.7	2.0*	2.4*	2.3
Dizziness	1.0	1.2	0.6	0.7	1.5	1.8
Irritated nose	1.0	1.5	0.8	0.8	1.9	2.2
Water, burning eyes	1.6*	1.8*	1.7*	1.8*	1.8*	0.9
Bleeding gums	1.6	1.5	2.1	0.7	1.1	1.2
Rashes	0.9	0.9	1.2	1.2	0.7	0.7
Frequent nausea	0.8	0.9	NC	NC	NC	NC
Chest pain	1.3	1.5	1.2	1.3	1.5	1.7

* Statistically significant at $p < 0.10$.

† NC, not calculated because a cell had fewer than 2 observations.

Table 32.—Comparison of reproductive outcomes among women aged 15 years or older who have ever been pregnant.

Outcome	Ashumet Valley (n = 34)	Briarwood (n = 35)	Forestdale (n = 74)	Picture Lakes (n = 72)	Comparison (n = 117)	Chi-square p value
Number of times pregnant						0.197
1	4 (12%)	6 (17%)	10 (13%)	9 (13%)	10 (9%)	
2	15 (44%)	8 (23%)	22 (29%)	22 (31%)	30 (26%)	
3	6 (18%)	14 (40%)	24 (32%)	13 (18%)	32 (27%)	
4	3 (9%)	2 (6%)	9 (12%)	13 (18%)	26 (22%)	
5 or more	6 (18%)	5 (14%)	10 (13%)	15 (21%)	19 (16%)	
Mean number times pregnant	3.1	2.8	2.9	3.5	3.4	NA
Number of live births						0.384
0	1 (3%)	3 (9%)	2 (3%)	2 (3)	2 (2%)	
1	5 (15%)	7 (20%)	14 (19%)	11 (15%)	18 (16%)	
2	18 (53%)	9 (26%)	33 (44%)	27 (38%)	48 (41%)	
3	3 (9%)	12 (34%)	16 (21%)	15 (21%)	28 (24%)	
4 or more	7 (21%)	4 (11%)	10 (13%)	17 (24%)	21 (18%)	
Mean number of live births	2.4	2.3	2.9	2.8	2.6	NA
Ever had a miscarriage	11 (32%)	12 (34%)	22 (29%)	27 (38%)	46 (39%)	0.684
Ever had a child with a birth defect	3 (9%)	1 (3%)	5 (7%)	10 (14%)	8 (7%)	0.300
Ever had a still birth	1 (3%)	0 (0%)	0 (0%)	3 (4%)	5 (4%)	0.320
Ever had a miscarriage since moving to current home	5 (15%)	6 (17%)	5 (7%)	7 (10%)	12 (10%)	0.489
Ever had a still birth since moving to current home	0	0	0	0	0	NA
Ever had a child with a birth defect since moving to current home	1	4	4	1	1	NA
Mean current age	48.3	46.6	47.6	50.6	47.8	NA
Mean years living in current home	14.0	8.9	11.5	14.5	12.3	NA

Table 33.—Comparison of mean biomarker results for water/air pathway target areas and comparison area, 1993 data collection only.*

Test	Mean	Standard Deviation	Range	Sample size	t-test p-value
White blood cell count ($\times 10^3$)					
Ashumet Valley	7.72	2.02	3.3-15.1	102	0.049
Briarwood	7.92	1.97	4.0-16.7	98	0.005
Comparison area	7.22	2.11	3.3-13.8	200	-----
Hemoglobin					
Ashumet Valley	13.77	1.26	10.9-16.9	102	0.602
Briarwood	13.98	1.25	11.7-17.1	98	0.423
Comparison area	13.85	1.26	09.6-17.2	200	-----
Hematocrit					
Ashumet Valley	40.39	3.56	33-50	102	0.438
Briarwood	40.90	3.66	34-50	98	0.706
Comparison area	40.73	3.59	30-50	200	-----
Blood Urea Nitrogen					
Ashumet Valley	15.43	5.02	6-35	101	0.371
Briarwood	15.32	5.20	7-35	98	0.497
Comparison area	14.91	4.03	7-31	197	-----
Serum creatinine					
Ashumet Valley	0.93	0.22	0.5-1.5	101	0.294
Briarwood	0.92	0.22	0.5-1.7	98	0.515
Comparison area	0.90	0.19	0.5-1.4	197	-----
Serum albumin					
Ashumet Valley	4.58	0.29	3.7-5.1	101	0.479
Briarwood	4.56	0.28	4.0-5.3	98	0.805
Comparison area	4.55	0.27	3.9-5.3	197	-----
Serum GGT					
Ashumet Valley	29.4	49.8	6-436	101	0.449
Briarwood	25.7	26.6	5-215	98	0.915
Comparison area	25.3	30.9	6-323	197	-----
Serum AST					
Ashumet Valley	25.1	10.8	15-118	101	0.633
Briarwood	27.6	16.9	14-166	98	0.279
Comparison area	25.7	7.2	12-57	197	-----
Serum ALT					
Ashumet Valley	20.1	10.7	10-86	101	0.570
Briarwood	24.3	18.4	8-101	98	0.096
Comparison area	20.9	12.2	7-99	197	-----

Table 33.—Continued.

Test	Mean	Standard Deviation	Range	Sample Size	t-test p value
Creatinine-adjusted urine AAP†					
Ashumet Valley	4.89	3.03	0.68-18.26	92	0.628
Briarwood	5.27	2.94	0.10-17.75	85	0.620
Comparison area	5.08	3.05	0.06-15.95	187	-----
Creatinine-adjusted urine NAG§					
Ashumet Valley	1.25	2.76	0.11-26.70	93	0.514
Briarwood	0.96	0.68	0.15-4.02	85	0.341
Comparison area	1.06	0.99	0.15-8.96	187	-----
Creatinine-adjusted urine RBP¶					
Ashumet Valley	0.060	0.050	0.009-0.391	93	0.634
Briarwood	0.062	0.066	0.011-0.401	85	0.884
Comparison area	0.063	0.044	0.011-0.348	187	-----
Creatinine-adjusted urine albumin					
Ashumet Valley	7.7	6.9	1.6-39.1	93	0.235
Briarwood	17.3	64.8	1.5-578.1	85	0.271
Comparison area	9.4	16.7	1.7-208.1	187	-----

Table 33.—Continued.

Test	Mean	Standard Deviation	Range	Sample Size	t-test p value
IgG					
Ashumet Valley	1085	229	455-1914	102	0.076
Briarwood	1041	199	550-1585	97	0.837
Comparison area	1035	229	399-1659	196	-----
IgA					
Ashumet Valley	222	108	34-618	102	0.057
Briarwood	219	091	68-540	97	0.084
Comparison area	199	095	3-540	196	-----
IgM					
Ashumet Valley	136	61.0	36-343	102	0.434
Briarwood	147	66.0	48-411	97	0.333
Comparison area	142	71.5	43-750	196	-----
Total lymphocyte count					
Ashumet Valley	2343	724	938-4356	102	0.542
Briarwood	2493	851	520-5346	98	0.042
Comparison area	2291	685	1008-4640	200	-----
B Cell %					
Ashumet Valley	14.6	5.2	4-32	102	0.096
Briarwood	14.3	8.0	4-68	96	0.364
Comparison area	13.5	5.3	2-28	194	-----
T Cell %					
Ashumet Valley	69.1	7.1	54-83	102	0.490
Briarwood	71.2	9.7	22-87	96	0.044
Comparison area	69.7	7.0	47-85	194	-----

* No substantive changes or statistically significant changes in results occurred when outliers or persons with kidney or liver disease were excluded, when the data were transformed using the natural logarithm, or when the data were modeled using linear regression to control for the effects of age, sex, alcohol, and cigarette smoking.

† alanine aminopeptidase

§ N-acetyl-beta-D-glucosaminidase

¶ retinol-binding protein

Table 34.—Comparison of mean biomarker results for air-only pathway target areas and comparison area, 1993 and 1994 data collection phases combined.*

Test	Mean	Standard Deviation	Range	Sample Size	t-test p value
White blood cell count (x10 ³)					
Forestdale	7.01	1.88	3.4-13.1	199	0.483
Picture Lakes	7.14	1.89	3.8-13.8	198	0.785
Comparison area	7.14	1.98	3.3-21.6	300	-----
Hemoglobin					
Forestdale	13.92	1.17	11.7-18.3	199	0.982
Picture Lakes	14.00	1.23	10.3-17.6	198	0.525
Comparison area	13.93	1.29	9.6-18.0	300	-----
Hematocrit					
Forestdale	41.0	3.4	34-54	199	0.704
Picture Lakes	41.1	3.4	32-51	198	0.591
Comparison area	40.9	3.6	30-52	300	-----
Blood urea nitrogen					
Forestdale	14.9	4.9	6-37	199	0.722
Picture Lakes	15.0	4.1	7-30	196	0.772
Comparison area	15.1	4.2	6-34	297	-----
Serum creatinine					
Forestdale	0.92	0.20	0.5-1.9	199	0.756
Picture Lakes	0.91	0.20	0.5-1.5	196	0.835
Comparison area	0.91	0.19	0.5-1.8	297	-----
Serum albumin					
Forestdale	4.6	0.31	3.7-5.7	199	0.530
Picture Lakes	4.6	0.28	3.8-5.4	196	0.285
Comparison area	4.6	0.27	3.9-5.3	297	-----
Serum GGT					
Forestdale	26.3	26.4	6-202	199	0.824
Picture Lakes	27.2	35.8	5-311	196	0.624
Comparison area	25.7	28.1	4-323	297	-----
Serum AST					
Forestdale	26.0	6.8	14-67	199	0.743
Picture Lakes	27.6	12.2	12-126	196	0.171
Comparison area	26.2	7.3	12-57	297	-----
Serum ALT					
Forestdale	21.9	11.6	8-100	199	0.936†
Picture Lakes	23.1	13.8	8-87	196	0.287
Comparison area	21.8	12.5	6-99	297	-----

Table 34.—Continued.

Test	Mean	Standard Deviation	Range	Sample Size	t-test p value
Creatinine-adjusted urine AAP§					
Forestdale	5.02	3.12	0.07-22.64	182	0.497
Picture Lakes	5.27	3.32	0.02-23.12	183	0.914
Comparison area	5.23	3.40	0.06-28.35	281	-----
Creatinine-adjusted urine albumin					
Forestdale	19.0	95.08	0.8-1143.3	182	0.184
Picture Lakes	15.1	47.67	1.3-552.3	183	0.127
Comparison area	9.5	16.98	1.7-208.1	281	-----
Creatinine-adjusted urine NAG¶					
Forestdale	1.01	0.91	0.12-5.34	182	0.201
Picture Lakes	1.32	1.83	0.10-15.87	183	0.677
Comparison area	1.19	2.16	0.09-33.17	281	-----
Creatinine-adjusted urine RBP**					
Forestdale	0.072	0.054	0.011-0.41	182	0.681
Picture Lakes	0.079	0.074	0.010-0.77	183	0.520††
Comparison area	0.075	0.056	0.011-0.57	281	-----

Table 34.—Continued.

Test	Mean	Standard Deviation	Range	Sample Size	t-test p value
IgG					
Forestdale	1092	219	591-1842	199	0.143
Picture Lakes	1068	228	582-2010	195	0.695
Comparison area	1060	266	214-3100	296	----
IgA					
Forestdale	231	112	17-750	199	0.007
Picture Lakes	219	114	2-847	195	0.148
Comparison area	205	101	3-750	296	----
IgM					
Forestdale	153	93.0	37-788	199	0.674
Picture Lakes	152	84.6	35-889	195	0.754
Comparison area	149	76.2	5-750	296	----
Total lymphocyte count					
Forestdale	2193	731	836-5537	199	0.217
Picture Lakes	2279	744	635-5457	198	0.822
Comparison area	2298	1164	616-18576	300	----
B Cell %					
Forestdale	13.9	6.0	1-60	198	0.740
Picture Lakes	13.7	5.1	3-33	195	0.927
Comparison area	13.7	6.9	2-89	294	----
T Cell %					
Forestdale	69.6	8.4	37-87	198	0.565
Picture Lakes	69.7	7.5	42-87	195	0.642
Comparison area	70.1	8.1	6-88	294	----

* No substantive changes in statistical tests or magnitude of effect were noted when the data were modelled using linear regression controlling for age, sex, year of study, alcohol, and cigarette consumption. No changes were noted when outliers were dropped, when persons with kidney or liver disease were dropped, or when the data were transformed using the natural logarithm, with two exceptions.

† When participants with liver disease were removed and the data were transformed using the natural logarithm, participants in Forestdale were found to have statistically significantly higher mean ALT levels, $p=0.096$.

§ alanine aminopeptidase

¶ N-acetyl-beta-D-glucosaminidase

** retinol-binding protein

†† When participants with kidney disease were removed and the data were transformed using the natural logarithm, participants in Picture Lakes were found to have statistically significantly higher mean urine RBP levels, $p=0.092$.

Table 35.—Results of medical tests for the two communities with water pathways around Otis ANGB/Camp Edwards and the comparison community, May and June, 1993, including all participants regardless of current health.

Test	Ashumet		Briarwood		Comparison area
	No. (%)	OR (90% CI)	No. (%)	OR (90% CI)	No. (%)
White blood cell count					
High	4 (4%)	0.7 (0.3-1.8)	2 (2%)	0.4 (0.1-1.2)	11 (5%)
Low	2 (2%)	0.5 (0.1-1.7)	2 (2%)	0.5 (0.1-1.8)	8 (4%)
Normal	96 (94%)		97 (96%)		181 (90%)
Hemoglobin					
High	1 (1%)	NC¶	1 (1%)	NC	0 (0%)
Low*	9 (9%)	1.0 (0.5-2.0)	7 (7%)	0.8 (0.4-1.7)	18 (9%)
Normal	92 (90%)		90 (92%)		182 (91%)
Hematocrit					
High	0 (0%)	NC	1 (1%)	NC	0 (0%)
Low*	17 (17%)	1.1 (0.6-1.8)	13 (13%)	0.8 (0.5-1.5)	32 (16%)
Normal	85 (83%)		84 (86%)		168 (84%)
% Lymphocytes					
High	1 (1%)	NC	4 (4%)	0.9 (0.3-2.8)	7 (3%)
Low*	17 (17%)	1.1 (0.7-2.0)	17 (17%)	1.0 (0.6-1.7)§	29 (14%)
Normal	84 (82%)		79 (79%)		164 (82%)
% Eosinophils					
High	7 (7%)	1.8 (0.7-4.2)	5 (5%)	1.3 (0.5-3.4)	8 (4%)
Normal	95 (93%)		93 (95%)		192 (96%)
Blood urea nitrogen					
High*	6 (6%)	1.2 (0.5-2.8)	8 (8%)	1.7 (0.8-3.7)	10 (5%)
Normal or low	95 (94%)		90 (92%)		187 (95%)
Serum creatinine					
High	8 (8%)	2.3 (1.0-5.5)	2 (2%)	0.6 (0.2-2.1)	7 (4%)
Normal or low	93 (92%)		96 (98%)		190 (96%)
Serum albumin					
High	0 (0%)	NC	1 (1%)	NC	1 (1%)
Normal	101 (100%)		97 (99%)		196 (99%)
Liver Enzymes (GGT, AST, ALT)					
High (2 of 3 high)	2 (2%)	0.7 (0.2-2.6)	5 (5%)	1.8 (0.7-4.9)	6 (3%)
Normal (else)	100 (98%)		93 (95%)		198 (97%)

Table 35.—Continued.

Test	Ashumet		Briarwood		Comparison area
	No. (%)	OR (90% CI)	No. (%)	OR (90% CI)	No. (%)
Creatinine-adjusted urine AAP†					
High*	5 (5%)	1.0 (0.4-2.6)	3 (4%)	0.7 (0.2-1.9)	10 (5%)
Normal	87 (95%)		82 (96%)		177 (95%)
Creatinine-adjusted urine albumin					
High	0 (0%)	NC	3 (4%)	2.2 (0.6-8.5)	3 (2%)
Normal	93 (100%)		82 (96%)		184 (98%)
Creatinine-adjusted urine NAG**					
High	3 (3%)	1.0 (0.3-3.3)	2 (2%)	0.7 (0.2-2.8)	6 (3%)
Normal	90 (97%)		83 (98%)		181 (97%)
Creatinine-adjusted urine RBP††					
High	3 (3%)	0.8 (0.2-2.3)	2 (2%)	0.5 (0.2-2.0)	8 (4%)
Normal	90 (97%)		83 (98%)		179 (96%)
IgG					
High	2 (2%)	NC	0 (0%)	NC	0 (0%)
Low	5 (5%)	1.4 (0.5-3.8)	2 (2%)	0.6 (0.2-2.1)	7 (4%)
Normal	95 (93%)		95 (98%)		189 (96%)
IgA					
High*	16 (16%)	2.0 (1.1-3.6),	9 (9%)	1.1 (0.5-2.1)	17 (9%)
Low	2 (2%)	p=0.070	0 (0%)	NC	5 (2%)
Normal	84 (82%)	0.8 (0.3-3.3)	88 (91%)		174 (89%)
IgM					
High	5 (5%)	1.1 (0.4-2.8)	5 (5%)	1.1 (0.4-2.9)	9 (5%)
Low	3 (3%)	NC	0 (0%)	NC	1 (0%)
Normal	94 (92%)		92 (95%)		186 (95%)
T cells %					
High	0 (0%)	NC	11 (11%)	5.0 (2.2-11.5),	5 (3%)
Low	1 (1%)	NC	2 (2%)	p=0.002	1 (0%)
Normal	101 (99%)		83 (87%)	NC	188 (97%)
Total lymphocyte count					
Low*	13 (13%)	1.1 (0.6-2.0)	15 (15%)	1.3 (0.7-2.4)	24 (12%)
Normal	89 (87%)		83 (85%)		176 (88%)
B cell %					
High	2 (2%)	0.4 (0.1-1.3)	5 (5%)	1.0 (0.4-2.6)	5 (3%)
Low	0 (0%)	NC	0 (0%)	NC	5 (3%)
Normal	100 (98%)		91 (95%)		184 (95%)

* These outcomes were assessed for confounding in a multivariate logistic regression model including dummy variables for the 2 communities, age, sex, current smoking, and current alcohol consumption. Models for liver enzymes (GGT, AST, ALT) included terms for having hepatitis or cirrhosis or for ever taking over-the-counter painkillers such as aspirin, acetaminophen, or ibuprofen. Models for kidney tests included the additional term for ever taking painkillers. In cases where the model adjusted odds ratio was different by 10% or more from the crude, the model adjusted OR and 90% CI are presented.

† NC-Not calculated. Odds ratios and 90% confidence intervals were not calculated when an observed cell was fewer than 2 observations.

§ Result of logistic regression model presented.

† aminopeptidase

** N-acetyl-beta-D-glucosaminidase

†† retinol-binding protein

Table 36.—Results of medical tests for the two communities with air-only pathways around Otis ANGB/Camp Edwards and the comparison community, 1993 and 1994, including all participants regardless of current health.

Test	Forestdale		Picture Lakes		Comparison area
	No. (%)	OR (90% CI)*	No. (%)	OR (90% CI)	No. (%)
White blood cell count					
High	9 (5%)	0.9 (0.4-1.9)	5 (3%)	0.5 (0.2-1.1)	15 (5%)
Low	11 (6%)	1.2 (0.6-2.4)	9 (5%)	0.9 (0.5-1.9)	14 (5%)
Normal (referent)	179 (90%)		184 (93%)		271 (90%)
Hemoglobin					
High	1 (1%)	NC§	0 (0%)	NC	1 (0%)
Low†	25 (13%)	1.7 (1.0-2.7), p=0.093	14 (7%)	0.9 (0.5-1.6)	24 (8%)
Normal	173 (87%)		184 (93%)		275 (92%)
Hematocrit					
High	1 (1%)	NC	0 (0%)	NC	0 (0%)
Low†	32 (16%)	1.0 (0.7-1.5)	19 (10%)	0.6 (0.3-0.9), p=0.041	48 (16%)
Normal	166 (83%)		179 (90%)		252 (84%)
% Lymphocytes					
High	4 (2%)	0.7 (0.2-1.8)	6 (3%)	1.0 (0.4-2.4)	9 (3%)
Low†	32 (16%)	1.0 (0.6-1.5)	31 (16%)	1.0 (0.6-1.4)	49 (16%)
Normal	163 (82%)		161 (81%)		242 (81%)
% Eosinophils					
High	9 (5%)	1.2 (0.6-2.6)	8 (4%)	1.1 (0.5-2.4)	11 (4%)
Normal	190 (95%)		190 (96%)		289 (96%)
Blood urea nitrogen					
High†	10 (5%)	1.00 (0.50-1.98)	4 (2%)	0.39 (0.16-0.97) p=0.090	15 (5%)
Normal or low	189 (95%)		192 (98%)		282 (95%)
Serum creatinine					
High†	12 (6%)	1.67 (0.83-3.35)	7 (4%)	0.96 (0.43-2.17)	11 (4%)
Normal or low	187 (94%)		189 (96%)		286 (96%)
Serum albumin					
High	0 (0%)	NC	0 (0%)	NC	0 (0%)
Normal	199 (100%)		196 (100%)		297 (100%)
Liver enzymes (GGT, ALT or AST)					
High (2 of 3 high)	3 (1%)	0.56 (0.19-1.71)	7 (4%)	1.36 (0.58-3.23)	8 (3%)
Normal (else)	199 (98%)		192 (96%)		299 (97%)

Table 36.—Continued.

Test	Forestdale		Picture Lakes		Comparison area
	No. (%)	OR (90% CI)*	No. (%)	OR (90% CI)	No. (%)
Creatinine-adjusted urine AAP†					
High†	13 (7%)	1.1 (0.6-2.1)	16 (9%)	1.4 (0.8-2.5)	18 (6%)
Normal	169 (93%)		167 (91%)		263 (94%)
Creatinine-adjusted urine albumin					
High	6 (3%)	1.0 (0.4-2.5)	13 (7%)	2.3 (1.1-4.7), p=0.054	9 (3%)
Normal	176 (97%)		170 (93%)		272 (97%)
Creatinine-adjusted urine NAG**					
High	7 (4%)	0.8 (0.4-1.8)	10 (5%)	1.2 (0.6-2.4)	13 (5%)
Normal	175 (96%)		173 (95%)		268 (95%)
Creatinine-adjusted urine RBP††					
High†	10 (5%)	0.8 (0.4-1.7)	18 (10%)	1.37 (0.76-2.46)	18 (6%)
Normal	172 (95%)		165 (90%)		263 (94%)
IgG					
High	3 (2%)	1.5 (0.4-5.6)	1 (1%)	NC	3 (1%)
Low	1 (1%)	NC	2 (1%)	0.4 (0.1-1.3)	8 (3%)
Normal	195 (98%)		193 (98%)		285 (96%)
IgA					
High†	28 (14%)	1.8 (1.1-3.0), p=0.036	19 (10%)	1.2 (0.7-2.1)	24 (8%)
Low	4 (2%)		9 (5%)	1.8 (0.8-4.0)	8 (3%)
Normal	167 (84%)	0.8 (0.3-2.2)	168 (86%)		264 (89%)
IgM					
High†	11 (6%)	0.9 (0.5-1.7)	13 (7%)	1.1 (0.6-2.0)	18 (6%)
Low	2 (1%)	1.5 (0.3-7.7)	2 (1%)	1.5 (0.3-7.9)	2 (1%)
Normal	186 (93%)		181 (92%)		276 (93%)
T cells %					
High	9 (5%)	1.4 (0.6-3.0)	7 (4%)	1.1 (0.5-2.4)	10 (3%)
Low	7 (4%)	3.6 (1.2-10.6), p=0.050	4 (2%)	2.0 (0.6-7.1)	3 (1%)
Normal	182 (92%)		184 (94%)		281 (96%)
Total lymphocyte count					
Low†	24 (12%)	0.9 (0.6-1.4)	21 (11%)	0.7 (0.5-1.2)	41 (14%)
Normal	175 (88%)		177 (89%)		259 (86%)
B cell %					
High	8 (4%)	1.2 (0.5-2.6)	4 (2%)	0.6 (0.2-1.6)	10 (3%)
Low	4 (2%)	0.9 (0.3-2.4)	3 (2%)	0.6 (0.2-2.0)	7 (2%)
Normal	186 (94%)		188 (96%)		277 (94%)

* Odds ratio and 90% confidence interval. In each case, the "normal" category is the reference group for calculating ORs.

† These outcomes were assessed for confounding in a multivariate logistic regression model including dummy variables for the two target areas, age, sex, current smoking, and current alcohol consumption, and year of data collection. Models for liver enzymes (GGT, AST, ALT) included terms for having hepatitis or cirrhosis or for ever taking over-the-counter painkillers such as aspirin, acetaminophen, or ibuprofen. Models for kidney tests included the additional term for ever taking painkillers. In no case did the model adjusted OR differ by 10% or more from the crude, and therefore, crude results are presented.

‡ NC-Not calculated. Odds ratios and 90% confidence intervals were not calculated when an observed cell was fewer than 2 observations.

† alanine aminopeptidase

** N-acetyl-beta-D-glucosaminidase

†† retinol-binding protein

Table 37.—Results of medical tests for the two communities with air and water pathways around Otis ANGB/Camp Edwards and the comparison community, 1993 and 1994.

Test	Water/Air Pathways		Comparison area	Air-only Pathways		Comparison area
	No. (%)	OR (90% CI)		No. (%)	OR (90% CI)	
White Blood Cell Count						
High	6 (3%)	0.5 (0.2-1.2)	11 (5%)	14 (4%)	0.7 (0.4-1.3)	15 (5%)
Low	4 (2%)	0.5 (0.2-1.3)	8 (4%)	20 (5%)	1.1 (0.6-1.9)	14 (5%)
Normal	190 (95%)		181 (90%)	363 (91%)		271 (90%)
Hemoglobin						
High	2 (1%)	NC§	0 (0%)	1 (0%)	NC	1 (0%)
Low†	16 (8%)	0.9 (0.5-1.6)	18 (9%)	39 (10%)	1.3 (0.8-2.0)	24 (8%)
Normal	182 (91%)		182 (91%)	357 (90%)		275 (92%)
Hematocrit						
High	1 (1%)	NC	0 (0%)	1 (0%)	NC	0 (0%)
Low†	33 (17%)	0.9 (0.6-1.5)	32 (16%)	51 (13%)	0.8 (0.5-1.1)	48 (16%)
Normal	169 (85%)		168 (84%)	345 (87%)		252 (84%)
% Lymphocytes						
High	4 (2%)	0.6 (0.2-1.6)	7 (3%)	10 (3%)	0.8 (0.4-1.8)	9 (3%)
Low†	33 (17%)	1.1 (0.7-1.8)	29 (14%)	63 (16%)	1.0 (0.7-1.4)	49 (16%)
Normal	163 (82%)		164 (82%)	324 (82%)		242 (81%)
% Eosinophils						
High	12 (6%)	1.5 (0.7-3.3)	8 (4%)	17 (4%)	1.2 (0.6-2.3)	11 (4%)
Normal	188 (94%)		192 (96%)	380 (96%)		289 (96%)
Blood Urea Nitrogen						
High†	14 (7%)	1.4 (0.7-2.9)	10 (5%)	14 (4%)	0.7 (0.4-1.3)	15 (5%)
Low or Normal	185 (93%)		187 (95%)	381 (96%)		282 (95%)
Serum Creatinine						
High	10 (5%)	1.4 (0.6-3.3)	7 (4%)	19 (5%)	1.3 (0.7-2.5)	11 (4%)
Normal or Low	189 (95%)		189 (96%)	376 (95%)		286 (96%)
Serum albumin						
High	0 (0%)	NC	0 (0%)	0 (0%)	NC	0 (0%)
Normal	199 (100%)		197 (100%)	395 (100%)		297 (100%)
Liver enzymes (GGT, AST, ALT)						
High (2 of 3 high)	7 (4%)	1.2 (0.5-3.0)	6 (3%)	10 (2%)	1.0 (0.4-2.1)	8 (3%)
Normal (else)	193 (96%)		198 (97%)	391 (98%)		299 (97%)

Table 37.—Continued

Test	Water/Air Pathways		Comparison area	Air-only Pathways		Comparison area
	No. (%)	OR (90% CI)		No. (%)	OR (90% CI)	
Creatinine-adjusted urine AAP†						
High†	8 (5%)	0.8 (0.4-1.9)	10 (5%)	29 (8%)	1.3 (0.8-2.1)	18 (6%)
Normal	169 (95%)		177 (95%)	336 (92%)		263 (94%)
Creatinine-adjusted urine albumin						
High	3 (2%)	1.1 (0.3-4.1)	3 (2%)	19 (5%)	1.7 (0.9-3.3)	9 (3%)
Normal	175 (98%)		184 (98%)	346 (95%)		272 (97%)
Creatinine-adjusted urine NAG**						
High	5 (3%)	0.9 (0.3-2.4)	6 (3%)	17 (5%)	1.0 (0.5-1.9)	13 (5%)
Normal	173 (97%)		181 (97%)	348 (95%)		268 (95%)
Creatinine-adjusted urine RBP						
High	5 (3%)	0.7 (0.3-1.7)	8 (4%)	28 (8%)	1.0 (0.6-1.7)§§	18 (6%)
Normal	173 (97%)		179 (96%)	337 (92%)		263 (94%)
IgG						
High	2 (1%)	NC	0 (0%)	4 (1%)	1.0 (0.3-3.5)	3 (1%)
Low	7 (4%)	1.0 (0.1-1.6)	7 (4%)	3 (1%)	0.3 (0.1-0.8), p=0.044	8 (3%)
Normal	190 (95%)		189 (96%)	388 (98%)		285 (96%)
IgA						
High†	25 (13%)	1.5 (0.9-2.6)	17 (9%)	47 (12%)	1.5 (1.0-3.4), p=0.099	24 (8%)
Low	2 (1%)	0.4 (0.1-1.6)	5 (2%)	13 (3%)	1.3 (0.6-2.7)	8 (3%)
Normal	172 (86%)		174 (89%)	335 (85%)		264 (89%)
IgM						
High	10 (5%)	1.1 (0.5-2.4)	9 (5%)	24 (6%)	0.9 (0.5-1.5)¶¶	18 (6%)
Low	3 (2%)	NC	1 (0%)	4 (1%)	1.5 (0.4-6.2)	2 (1%)
Normal	186 (93%)		186 (95%)	367 (93%)		276 (93%)
T cells %						
High	11 (6%)	2.2 (0.9-5.4)	5 (3%)	16 (4%)	1.2 (0.6-2.4)	10 (3%)
Low	3 (2%)	NC	1 (0%)	11 (3%)	2.8 (1.0-7.9)	3 (1%)
Normal	184 (93%)		188 (97%)	366 (93%)	p=0.100	281 (96%)
Total lymphocyte count						
Low†	28 (14%)	1.2 (0.7-2.0)	24 (12%)	45 (11%)	0.8 (0.6-1.2)	41 (14%)
Normal	172 (86%)		176 (88%)	352 (89%)		259 (86%)
B cell %						
High	7 (4%)	1.3 (0.5-3.6)	5 (3%)	12 (3%)	0.8 (0.4-1.7)***	10 (3%)
Low	0 (0%)	NC	5 (3%)	7 (2%)	0.7 (0.3-1.8)	7 (2%)
Normal	191 (96%)		184 (95%)	374 (95%)		277 (94%)

* Odds ratio and 90% confidence interval. In each case, the "normal" category is the reference group for calculating ORs.

† These outcomes were assessed for confounding in a multivariate logistic regression model including dummy variables for the combined target area, age, sex, current smoking, and current alcohol consumption. Models for liver enzymes (GGT, AST, ALT) included terms for having hepatitis or cirrhosis or for ever taking over the counter painkillers such as aspirin, acetaminophen, or ibuprofen. Models for kidney tests included the additional term for ever taking painkillers. In cases where the model adjusted odds ratio was different by 10% or more from the crude, the model adjusted OR and 90% CI are presented.

§ Not calculated. Odds ratios and 90% confidence intervals were not calculated when a cell had fewer than two observations.

† alanine aminopeptidase

** N-acetyl-beta-D-glucosaminidase

†† retinol-binding protein

§§ Results of logistic regression model controlling for sex and year of study.

¶¶ Results of logistic regression model controlling for age, sex, and year of study.

*** Results of logistic regression model controlling for sex, smoke, alcohol, and year of study.

Table 38.—Summary of medical test results where there was a two-fold or greater difference in proportion of participants outside of the reference range or where there was a statistically significant difference in mean test values.

Test	Ashumet Valley	Briarwood	Forestdale	Picture Lakes
	OR (90% CI)	OR (90% CI)		
White blood cell count				
High	—*	0.4	—	0.5
Low	0.5	0.5	—	—
Mean difference	7%, $p=0.049$	10%, $p=0.005$	—	—
Hemoglobin				
High	—	—	—	—
Low	—	—	1.7, $p=0.093$	—
Mean difference	—	—	—	—
Hematocrit				
High	—	—	—	—
Low	—	—	—	0.6, $p=0.041$
Mean difference	—	—	—	—
% Lymphocytes				
High	—	—	—	—
Low	—	—	—	—
Mean difference	—	—	—	—
% Eosinophils				
High	—	—	—	—
Mean difference	—	—	—	—
Blood urea nitrogen				
High	—	—	—	0.4, $p=0.090$
Mean difference	—	—	—	—
Serum creatinine				
High	2.3	—	—	—
Mean difference	—	—	—	—
Serum albumin				
High	—	—	—	—
Mean difference	—	—	—	—
Liver Enzymes (GGT, AST, ALT)				
High (2 of 3 high)	—	—	—	—
Mean difference	—	16%, $p=0.096$ ALT	—	—

Table 38.—Continued.

Test	Ashumet Valley	Briarwood	Forestdale	Picture Lakes
	OR (90% CI)	OR (90% CI)		
Creatinine-adjusted urine AAP† High Mean difference	-- --	-- --	-- --	-- --
Creatinine-adjusted urine albumin High Mean difference	-- --	2.2 84%, p=0.271	1.0 100%, p=0.184	2.3, p=0.054 59%, p=0.127
Creatinine-adjusted urine NAG§ High Mean difference	-- --	-- --	-- --	-- --
Creatinine-adjusted urine RBP¶ High Mean difference	-- --	0.5 --	-- --	-- --
IgG High Low Mean difference	-- -- 5%, p=0.076	-- -- --	-- -- --	-- 0.4 --
IgA High Low Mean difference	2.0, p=0.070 -- 12%, p=0.057	-- -- 10%, p=0.084	1.8, p=0.036 -- 13%, p=0.007	-- -- --
IgM High Low Mean difference	-- -- --	-- -- --	-- -- --	-- -- --
T cells % High Low Mean difference	-- -- --	5.0, p=0.002 -- 2%, p=0.044	-- 3.6, p=0.05 --	-- 2.0 --
Total lymphocyte count Low Mean difference	-- --	-- 9%, p=0.042	-- --	-- --
B cell % High Low Mean difference	0.4 -- 8%, p=0.096	-- -- --	-- -- --	-- -- --

* -- indicates that the test result was not substantially different between the target and comparison communities.

† alanine aminopeptidase

§ N-acetyl-beta-D-glucosaminidase

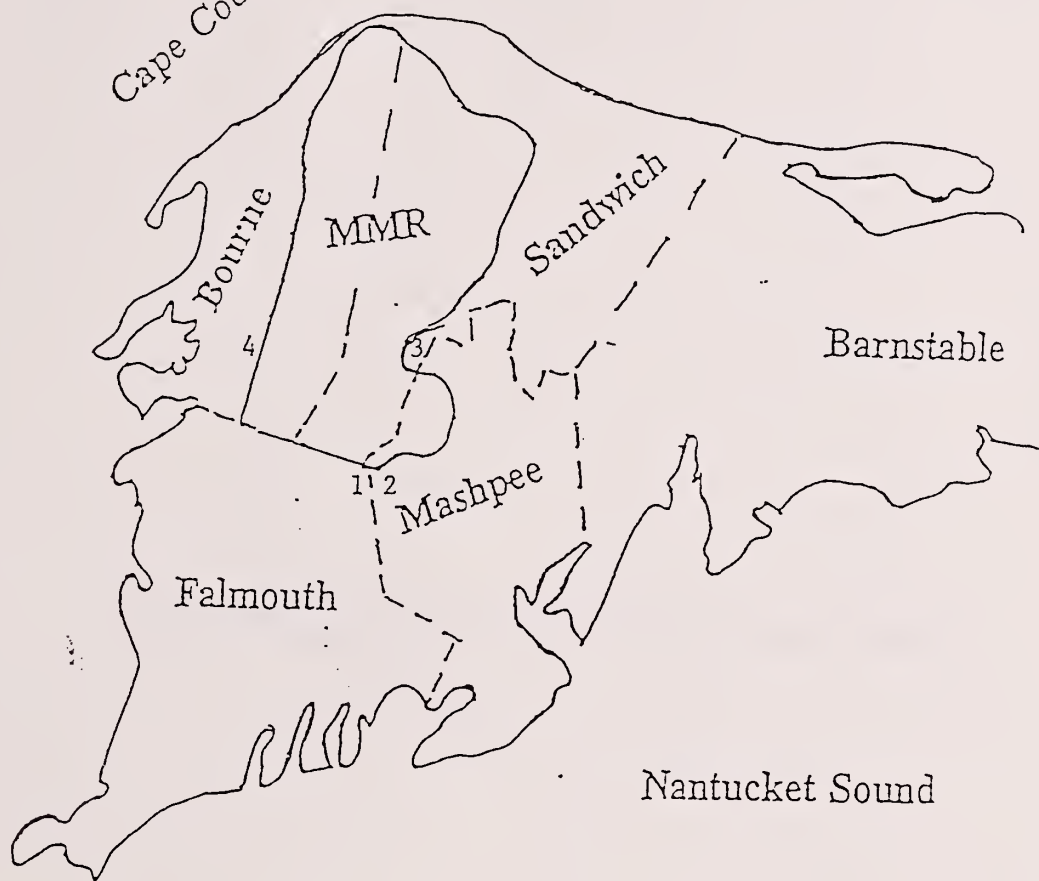
¶ retinol-binding protein

FIGURES

Figure 1. Study area

Cape Cod Bay

Cape Cod Canal

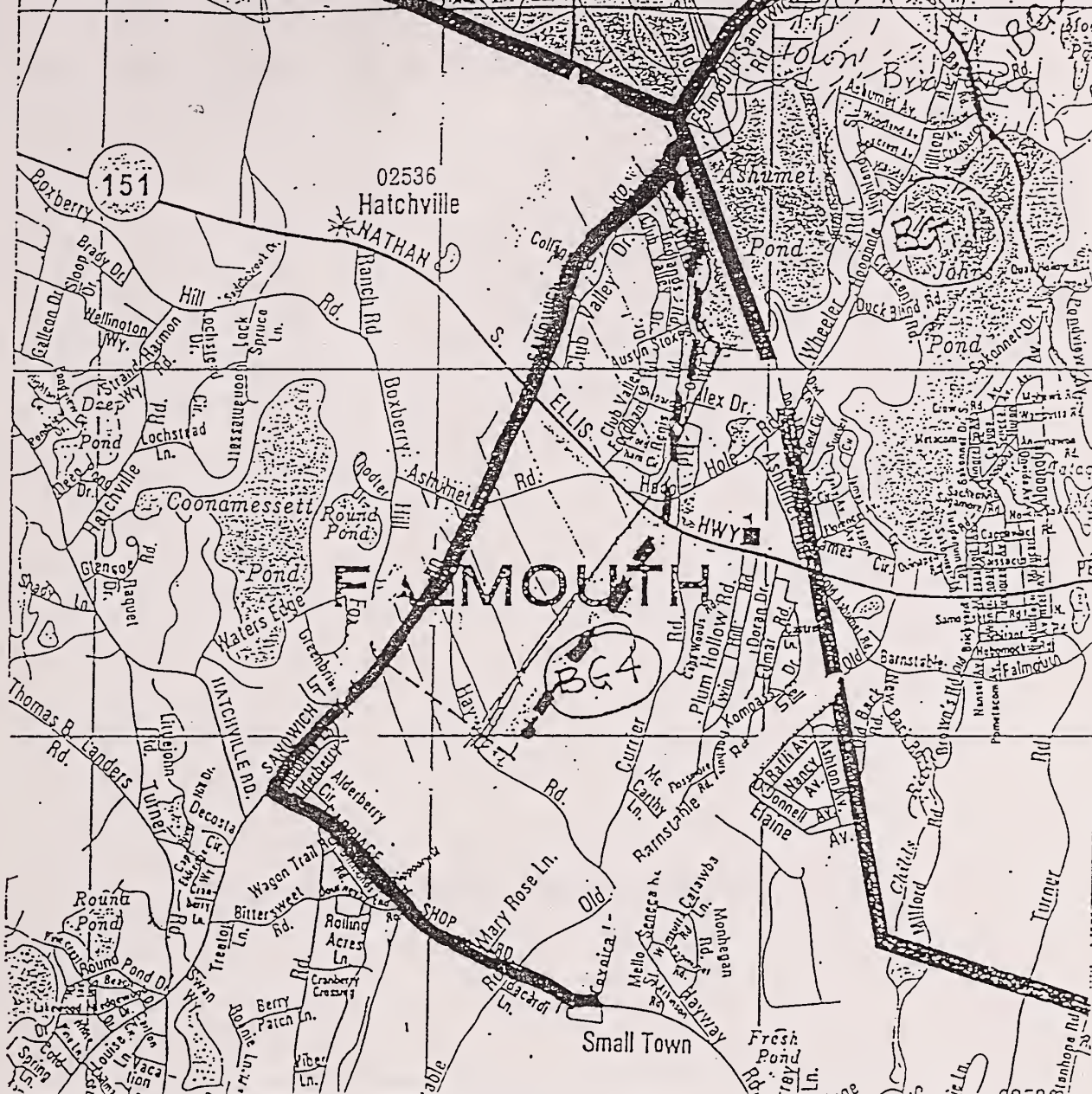


TARGET AREAS:

- Ashumet Valley = 1
- Briarwood = 2
- Forestdale = 3
- Picture Lakes = 4

MMR and Upper Cape Cod town boundaries

Figure 2. Study area boundaries for Ashumet Valley, Falmouth



ASHUMET VALLEY

Town: Falmouth

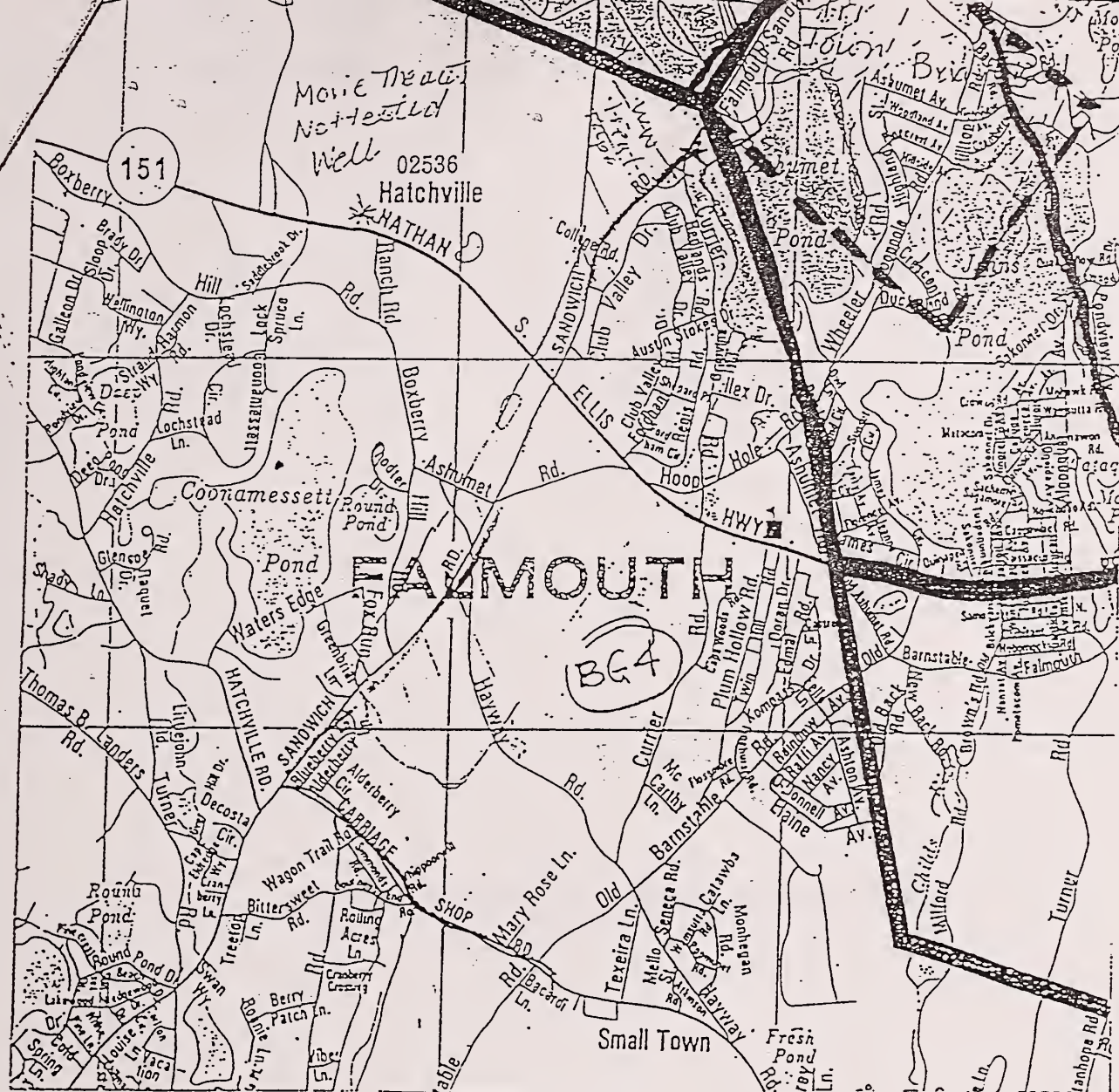
Target Area Community: Ashumet Valley

Target Area Street Boundaries: Currier Road (North and East), Hayway Road
{.5 miles west of Sandwich Road} (South), Sandwich Road (West).

1990 U.S. Census Block Group: 4 Population: 2,010 %Female:53.6% %Male:46.4%
Median Income: \$32,679 Median Age:31.3
% High School Graduates: 54%

1990 U.S. Census Block Group Street Boundaries: Falmouth/Mashpee town lines
(North), Sandwich Road (West), Milford Road (East), Carriage Shop Road
(South).

Figure 3. Study area boundaries for Briarwood, Mashpee



BRIARWOOD

Town: Mashpee

Target Area Community: Briarwood

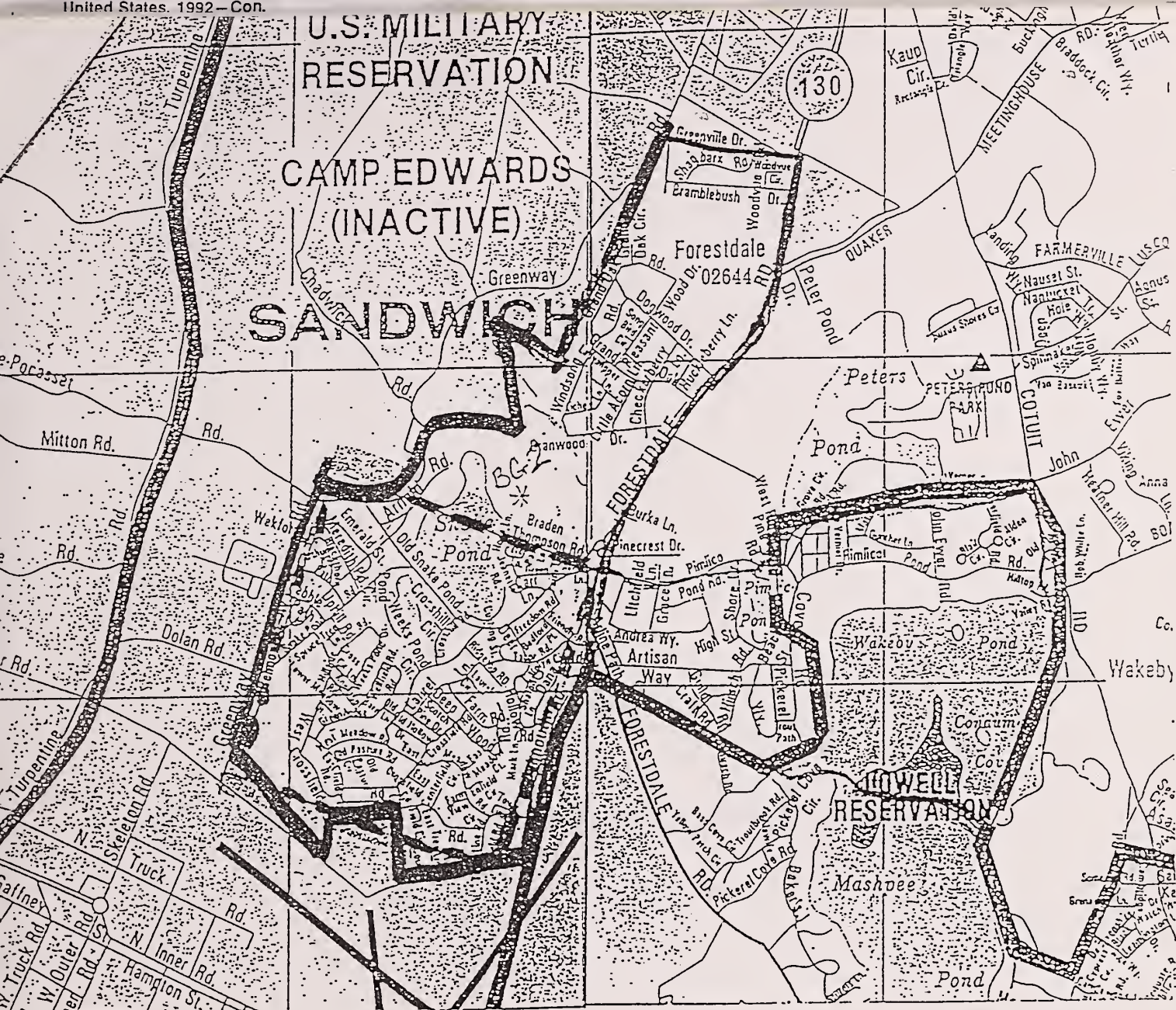
Target Street Boundaries: Back Road (Northeast), Hoophole and Crescent Road (Southwest); Otis Air National Guard Base/Camp Edwards (West and Northwest), Ashument Pond (South).

1990 U.S. Census Block Group: 1 Population: 1,152 %Female:54.0% %Male:46.0%
Median Income: \$27,112 Median Age:34.7
% High School Graduates: 67%

1990 U.S. Census Block Group Street Boundaries: Back Road (North, John's Pond (Northeast), Pondview Avenue (East); Nathan S. Ellis Hwy/Hwy 151 (South)

Figure 4. Study area boundaries for Forestdale, Sandwich

Table 61. Number of selected reported chronic conditions per 1,000 persons, by geographic region and place of residence:
United States, 1992—Con.



FORESTDALE

Town: Sandwich

Target Area Community: Forestdale

Target Street Boundaries: Braden Thompson Road (North), Otis Air National Guard Base/Camp Edwards (West and South), Falmouth Road (East)

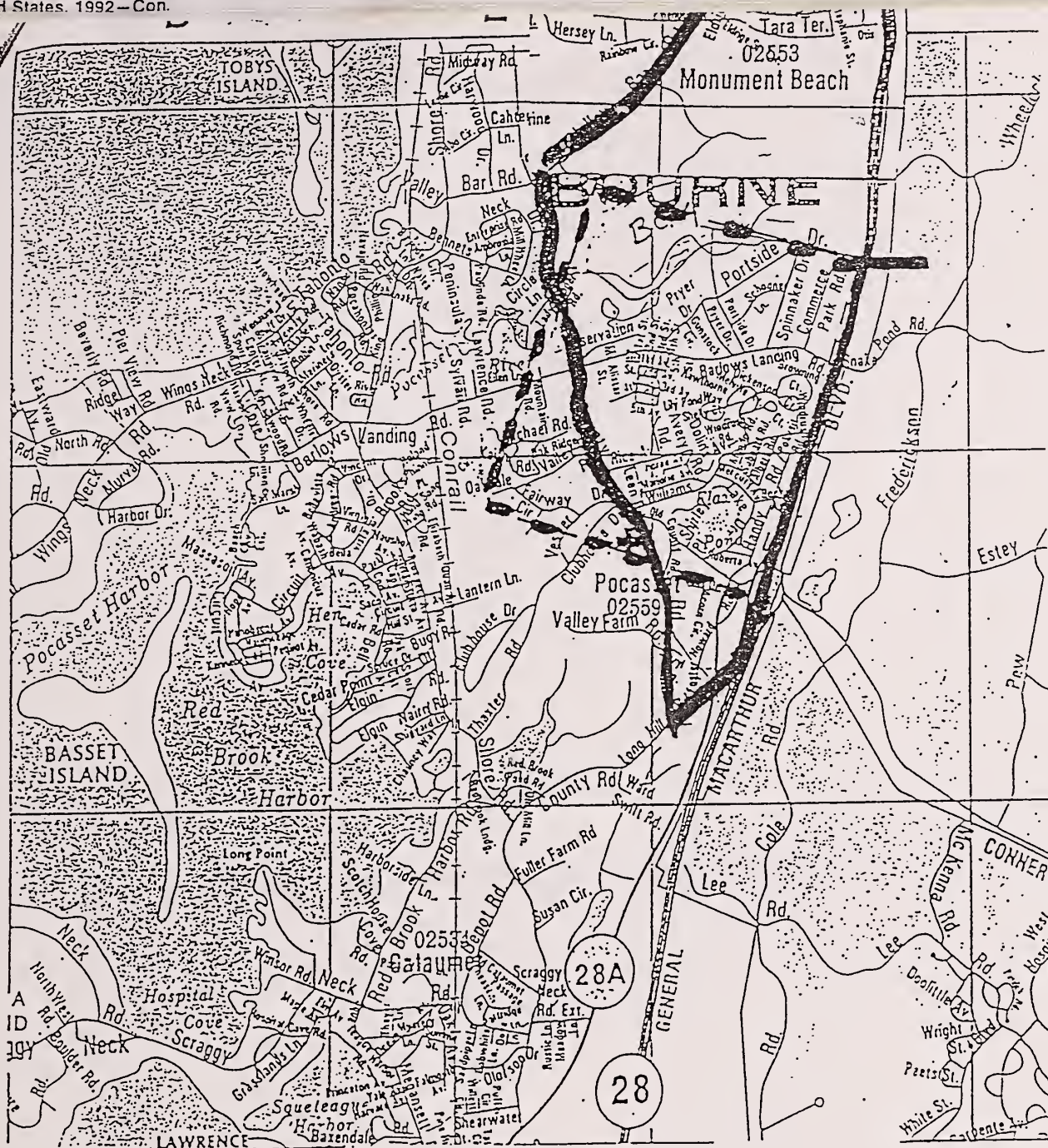
1990 U.S. Census Block Group: 2 Population: 2,502 %Female:49.3% %Male:50.7%
Median Income: \$45,587 Median Age:30.8
% High School Graduates: 65%

1990 U.S. Census Block Group Street Boundaries: Greenville Drive (North), Otis Air National Guard Base/Camp Edwards (West and South), Hwy 130/Forestdale Road (East)

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Figure 5. Study area boundaries for Picture Lakes, Bourne

Table 61. Number of selected reported chronic conditions per 1,000 persons, by geographic region and place of residence:
United States, 1992—Con.



PICTURE LAKES

Town: Bourne Target Area Community: Picture Lakes

Target Area Boundaries: Portside Drive (North), Hwy 28 and Otis Air National Guard Base/Camp Edwards (East), County Road (up to Rolling Oaks Drive) Clubhouse Drive and Vesper Drive, Oakdale Valley (until dead end) (South), Michael Road, Mountain Road and Barlows Landing, Lady Slipper Road (West).

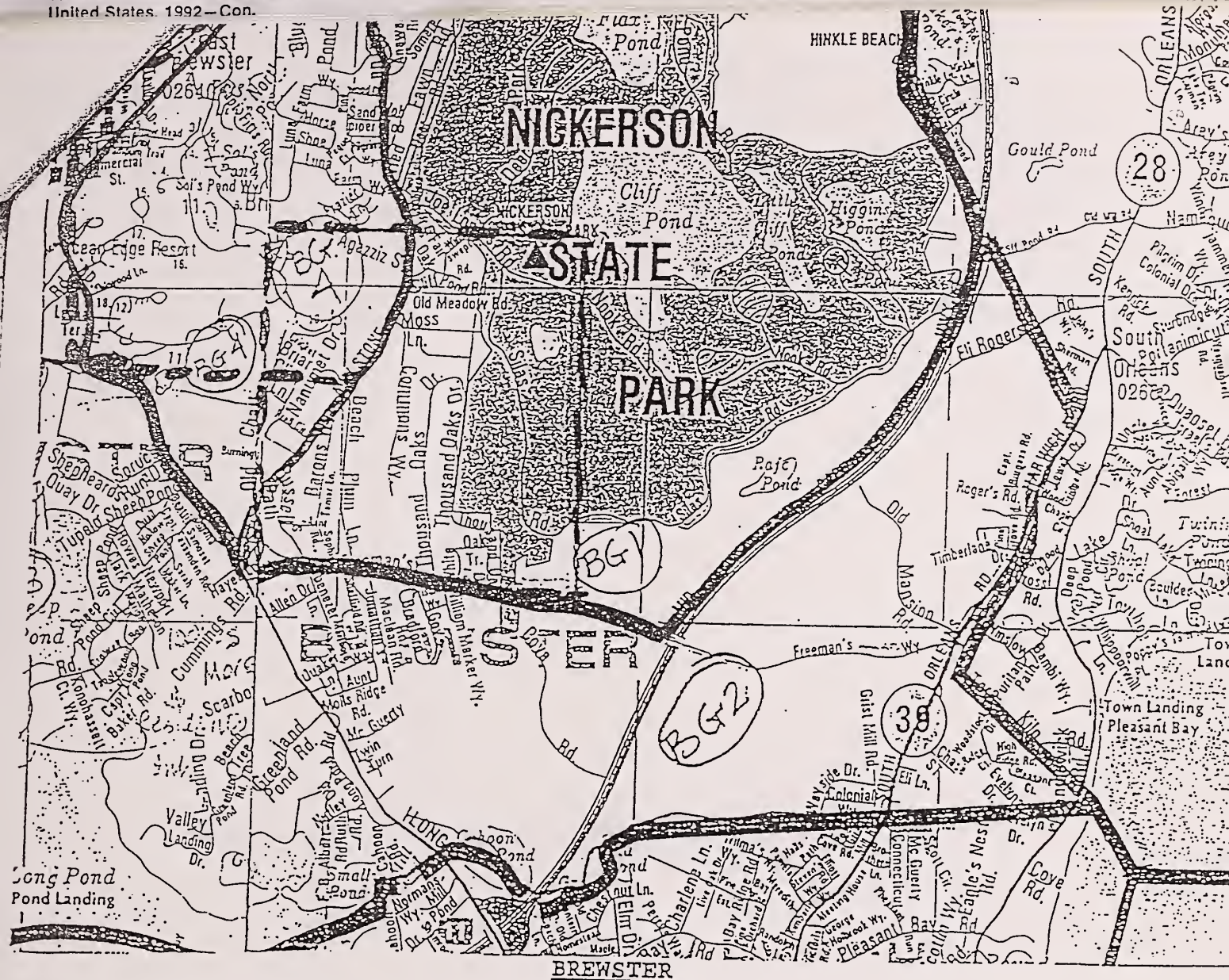
1990 U.S. Census Block Group: 4 Population: 1,394 %Female:50.2% %Male:48.8%
Median Income: \$40,662 Median Age:35.0
% High School Graduates: 68%

1990 U.S. Census Block Group Street Boundaries: Valley Bar Road and Clay Pond Road (North), County Road (South and Southwest), Hwy 28 and Otis Air National Guard Base/Camp Edwards (East),

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Figure 6. Study area boundaries for the comparison area

Table 61. Number of selected reported chronic conditions per 1,000 persons, by geographic region and place of residence:
United States, 1992—Con.



Town: Brewster Comparison Area Community: Brewster (Block Group 1&4)

Comparison Area 1 Street Boundaries: Fern Way and Millstone (North), Freeman's Way (South), Old Chatham Road (West), Nickerson State Park (East).

Comparison Area 2 Street Boundaries: Hwy 6A (North), Millstone Road (East), Long Pond Road (South), and Snow Road (West).

1990 U.S. Census Block Group: 1 (Area 1) Population: 1,717 %Female:51.3%
%Male:48.7% Median Income: \$36,750 Median Age:37.7
% High School Graduates: 67.3%

1990 U.S. Census Block Group Street Boundaries: Hwy 6A (North), Hwy 6 (East), Freeman's Way (South), Millstone Road (West).

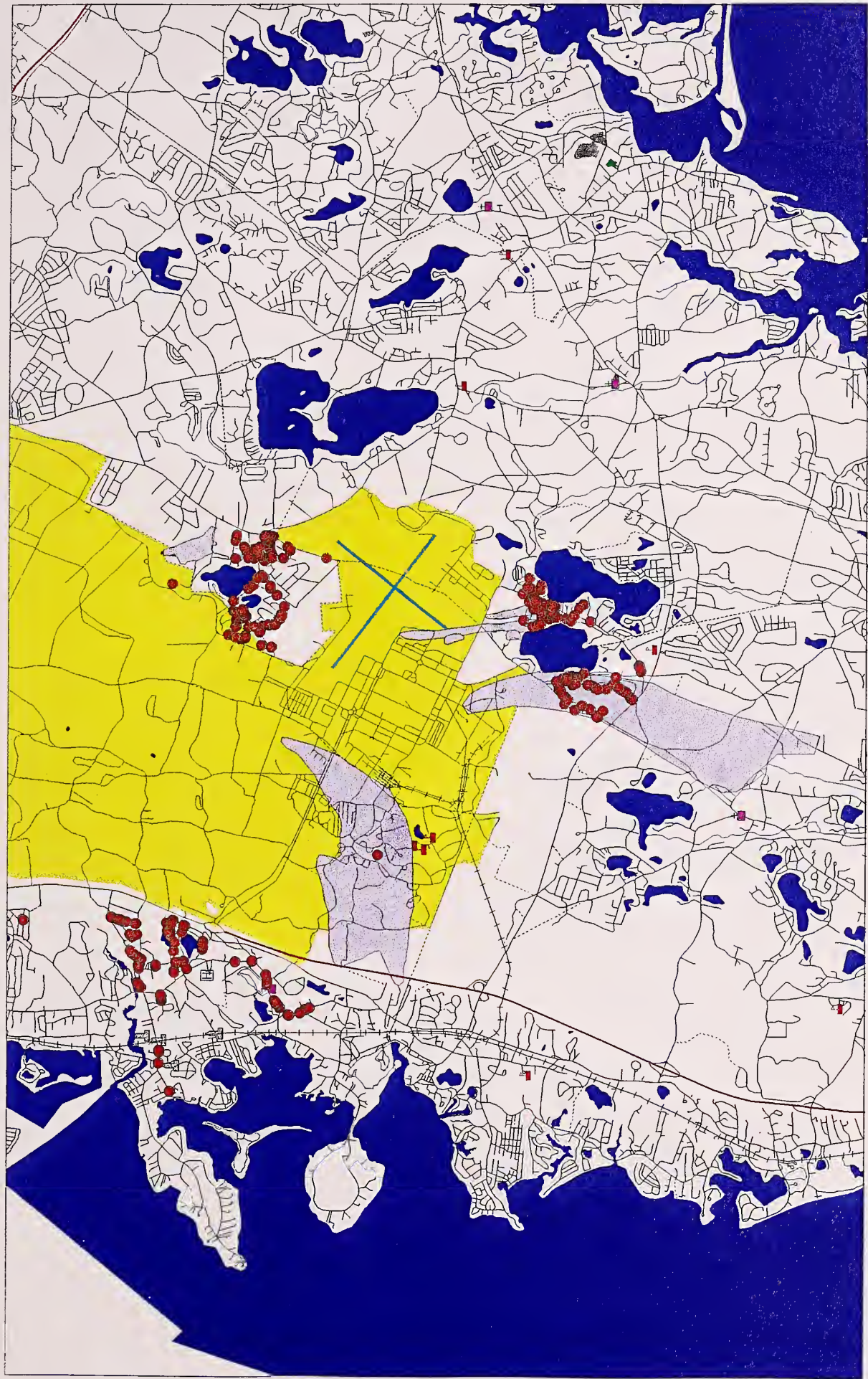
1990 U.S. Census Block Group: 4 (Area 2) Population: 1,232 %Female:53.8%
%Male:46.2% Median Income: \$30,511 Median Age:32.4
% High School Graduates: 64.0%

1990 U.S. Census Block Group Street Boundaries: South of Hwy 6A (North), Millstone Road (East), Long Pond Road (South), Snow Road (West).

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Figure 7: Map of study areas around the MMR, location of study participants,
and location of groundwater plumes

Table 61. Number of selected reported chronic conditions per 1,000 persons, by geographic region and place of residence:
United States. 1992—Con.



Legend:

- Red dot=approximate location of participant address
- Purple= groundwater plumes
- Yellow=Massachusetts Military Reservation
- Blue = Ponds and ocean

Draft for Public Comment -- Do Not Cite or Quote -- July 3, 1996

Figure 8. Biologic Tests Used to Measure the Liver, Kidney, and Immune Systems

Liver (hepatobiliary system)

Serum aspartate aminotransferase (AST or SGOT)
Serum alanine aminotransferase (ALT or SGPT)
Serum gammaglutamyl transferase (GGT)
Serum albumin

Kidney (renal system)

Blood creatinine
Blood urea nitrogen (BUN)
Urine N-acetyl-beta-D-glucosaminidase (NAG)
Urine alanine aminopeptidase (AAP)
Urine retinol-binding protein (RBP)
Urine albumin

Immune System and Blood-Forming Organ

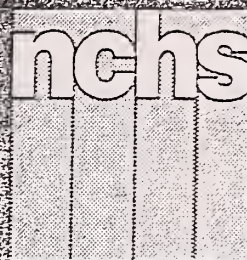
Immunoglobulins (IgA, IgG, IgM)
Hemoglobin and hematocrit
White blood cell count (with five part differential)
CD2 or CD3 lymphocytes (total T-cells)
CD4 lymphocytes (helper T-cells)
CD8 lymphocytes (mixed/natural killer cells)
CD8-CD3 lymphocytes (suppressor/cytotoxic cells)
CD19 or CD20 lymphocytes (B-cells)

Biological Indicator of Exposure to Lead - 1993 Participants Only

Venous blood lead screening

APPENDIX. National Health Interview Survey prevalence of selected illnesses

"The contents of the Appendices are presented in their entirety as submitted by the author and have not been revised to conform with Agency for Toxic Substances and Disease Registry editing guidelines."

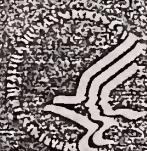


Vital and Health Statistics

From the CENTERS FOR DISEASE CONTROL AND PREVENTION National Center for Health Statistics

Current Estimates From the National Health Interview Survey, 1992

January 1994



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Center for Health Statistics



Copyright Information

All material appearing in this report is in the public domain and may be reproduced or copied without permission; citation as to source, however, is appreciated.

Suggested citation

Denson V and Marano MA. Current estimates from the National Health Interview Survey. National Center for Health Statistics. Vital Health Statistics (189). 1994.

Library of Congress Catalog Card Number 65-62623

Table 1. Number of acute conditions per 100 persons per year, by age and type of condition: United States, 1992

[Data are based on household interviews of the civilian noninstitutionalized population. The survey design, general qualifications, and information on the reliability of the estimates are given in appendix I. Definitions of terms are given in appendix II]

Type of acute condition	All ages	Under 5 years	5-17 years	18-24 years	25-44 years	45 years and over		
						Total	45-64 years	65 years and over
Number of acute conditions per 100 persons per year								
All acute conditions	181.8	385.0	239.9	185.2	161.7	116.7	114.0	121.0
Infective and parasitic diseases	22.4	59.0	45.2	20.9	16.2	6.6	7.1	5.8
Common childhood diseases	2.4	17.3	5.1	*0.6	*0.0	*—	*—	*—
Intestinal virus, unspecified	5.3	11.9	10.9	4.6	4.6	1.4	2.0	*0.5
Viral infections, unspecified	7.0	15.1	12.4	7.1	5.4	3.3	3.1	3.6
Other	7.7	14.7	16.7	8.6	6.2	1.9	2.0	*1.7
Respiratory conditions	85.6	159.5	119.1	86.4	80.4	52.8	55.5	43.4
Common cold	25.7	66.1	35.4	29.6	21.1	13.5	13.0	14.2
Other acute upper respiratory infections	9.9	16.4	17.7	9.8	8.0	5.5	6.0	4.8
Influenza	42.7	56.7	59.1	41.8	45.7	26.7	31.5	19.1
Acute bronchitis	4.1	11.0	4.1	*3.1	3.1	3.7	2.9	5.0
Pneumonia	1.6	*3.8	*1.2	*0.6	1.4	1.7	*0.6	3.4
Other respiratory conditions	1.8	5.5	*1.6	*1.6	1.1	1.7	*1.5	*2.0
Digestive system conditions	7.0	12.9	9.2	5.2	5.8	6.0	4.7	8.0
Dental conditions	1.1	*3.9	*0.7	*0.8	1.3	*0.6	*0.8	*0.3
Indigestion, nausea, and vomiting	3.7	6.7	7.0	*3.1	2.9	1.9	*1.6	*2.3
Other digestive conditions	2.2	*2.4	*1.6	*1.3	1.6	3.5	2.3	5.4
Injuries	23.7	24.5	28.6	31.3	24.8	17.1	14.8	20.9
Fractures and dislocations	3.1	*1.2	4.9	4.9	2.6	2.4	1.9	3.3
Sprains and strains	5.5	*0.9	5.5	9.1	7.4	3.6	3.6	3.6
Open wounds and lacerations	4.9	7.4	6.5	6.3	5.2	2.6	2.0	3.6
Contusions and superficial injuries	4.2	*2.8	5.8	5.4	3.9	3.7	2.8	5.0
Other current injuries	5.9	12.1	5.9	5.5	5.7	4.8	4.5	5.4
Selected other acute conditions	30.2	106.9	30.0	28.4	22.8	19.3	16.8	20.1
Eye conditions	1.2	*1.9	*0.4	*0.7	1.2	1.6	*1.1	*2.5
Acute ear infections	10.4	77.4	11.6	4.3	3.3	2.1	2.2	*1.8
Other ear conditions	1.7	4.3	3.1	*0.9	*0.8	1.4	*1.1	*1.8
Acute urinary conditions	3.2	*1.6	*1.7	4.4	3.2	4.0	3.3	5.1
Disorders of menstruation	0.5	...	*0.8	*0.6	*0.8	*0.2	*0.4	*—
Other disorders of female genital tract	0.9	*0.2	*0.4	*2.2	1.3	*0.5	*0.8	*0.1
Delivery and other conditions of pregnancy and puerperium	1.7	...	*0.2	5.9	3.4	*—	*—	...
Skin conditions	2.2	6.0	1.9	*2.2	1.4	2.3	2.3	*2.3
Acute musculoskeletal conditions	4.2	*0.7	*1.5	4.0	4.8	6.1	5.9	6.3
Headache, excluding migraine	1.6	*0.5	2.8	*2.1	1.8	*0.7	*1.0	*0.3
Fever, unspecified	2.6	14.2	5.7	*0.9	*0.8	*0.4	*0.7	*—
All other acute conditions	12.9	22.2	7.7	13.1	11.8	14.9	13.1	17.8

NOTES: Excluded from these estimates are conditions involving neither medical attention nor activity restriction.

The standard errors and relative standard errors (RSE's) can be computed by using parameter set I of table II, the frequencies of table 6, and the formula presented in rule 2 of appendix I. Estimates for which the numerator has an RSE of more than 30 percent are indicated with an asterisk.

Table 5. Number of acute conditions per 100 persons per year, by geographic region, place of residence, and type of condition: United States, 1992

[Data are based on household interviews of the civilian noninstitutionalized population. The survey design, general qualifications, and information on the reliability of the estimates are given in appendix I. Definitions of terms are given in appendix II]

Type of acute condition	Geographic region				Place of residence			
	Northeast	Midwest	South	West	MSA ¹		Not central city	Not MSA ¹
					All MSA ¹	Central city		
Number of acute conditions per 100 persons per year								
All acute conditions	168.8	186.4	173.5	201.0	179.7	177.1	181.4	169.4
Infective and parasitic diseases	24.4	17.8	29.9	14.2	21.6	16.3	23.7	25.2
Common childhood diseases	2.8	1.9	2.9	1.7	2.4	1.5	3.0	2.3
Intestinal virus, unspecified	8.2	1.9	8.8	*1.4	5.3	5.0	5.4	5.6
Viral infections, unspecified	7.2	5.0	10.8	3.1	6.5	5.5	7.1	8.7
Other	6.2	9.0	7.4	8.0	7.4	6.1	8.3	8.5
Respiratory conditions	76.9	95.4	68.3	109.1	86.3	87.1	85.8	83.3
Common cold	25.5	25.7	21.0	33.1	26.5	27.3	25.9	22.9
Other acute upper respiratory infections	10.5	10.8	9.4	8.9	9.8	9.2	10.1	10.1
Influenza	32.9	51.4	30.6	60.3	42.9	44.0	42.3	41.7
Acute bronchitis	4.7	3.1	4.1	4.4	3.9	3.3	4.3	4.7
Pneumonia	*1.2	1.8	2.0	*1.0	1.4	1.3	1.5	2.1
Other respiratory conditions	2.4	2.5	1.2	*1.3	1.8	2.0	1.6	1.8
Digestive system conditions	6.1	6.1	7.1	8.6	6.9	6.7	7.1	7.3
Dental conditions	*1.3	*0.5	1.3	*1.4	1.1	1.3	1.0	*1.2
Indigestion, nausea, and vomiting	3.2	4.0	3.3	4.3	3.7	3.1	4.0	3.7
Other digestive conditions	1.7	1.6	2.5	2.9	2.2	2.3	2.1	2.3
Injuries	20.6	23.4	24.6	25.5	22.4	22.6	22.3	25.3
Fractures and dislocations	3.2	3.0	2.6	3.8	3.1	2.9	3.2	3.2
Sprains and strains	4.3	4.9	5.9	6.7	5.3	5.5	5.1	6.1
Open wounds and lacerations	4.1	4.6	5.9	4.5	4.3	4.3	4.3	7.3
Contusions and superficial injuries	4.5	4.6	3.9	4.1	4.2	5.0	3.7	4.3
Other current injuries	4.5	6.2	6.3	6.5	5.5	4.7	6.1	7.4
Selected other acute conditions	29.4	29.9	30.5	31.5	30.0	29.0	30.7	30.7
Eye conditions	*1.3	*1.1	1.3	*1.1	1.1	1.3	1.0	*1.3
Acute ear infections	12.2	9.1	9.8	11.0	10.4	9.1	11.2	10.2
Other ear conditions	*1.5	1.8	2.1	*1.1	1.6	1.4	1.7	2.0
Acute urinary conditions	2.0	3.9	3.6	2.9	3.1	2.9	3.2	3.6
Disorders of menstruation	*0.5	*0.5	*0.7	*0.3	0.6	*0.4	*0.7	*0.5
Other disorders of female genital tract	*1.0	*1.0	*0.9	*0.5	0.9	*0.9	0.9	*0.9
Delivery and other conditions of pregnancy and puerperium	*0.9	1.5	1.8	2.6	1.7	2.1	1.5	1.6
Skin conditions	2.8	1.8	2.2	2.1	2.4	2.0	2.5	1.7
Acute musculoskeletal conditions	3.5	4.2	4.4	4.3	4.2	4.3	4.1	4.3
Headache, excluding migraine	*0.8	2.0	1.8	1.5	1.5	1.2	1.6	2.0
Fever, unspecified	1.9	2.8	1.9	4.2	2.7	3.4	2.2	2.5
All other acute conditions	12.3	13.9	13.1	12.2	12.5	13.4	11.9	14.7

¹MSA is metropolitan statistical area.

NOTES: Excluded from these estimates are conditions involving neither medical attention nor activity restriction.

The standard errors and relative standard errors (RSE's) can be computed by using parameter sets I and X of table II, the frequencies of tables 10 and 78, and the formula presented in rule 4 of appendix I. Estimates for which the numerator has an RSE of more than 30 percent are indicated with an asterisk.

Table 57. Number of selected reported chronic conditions per 1,000 persons, by age: United States, 1992

[Data are based on household interviews of the civilian noninstitutionalized population. The survey design, general qualifications, and information on the reliability of the estimates are given in appendix I. Definitions of terms are given in appendix II]

Type of chronic condition	All ages	Under 45 years				65 years and over		
		Total	Under 18 years	18-44 years	45-64 years	Total	65-74 years	75 years and over
Selected skin and musculoskeletal conditions		Number of chronic conditions per 1,000 persons						
Arthritis	132.5	34.1	*2.4	54.1	259.9	481.9	444.3	536.5
Gout, including gouty arthritis	8.4	2.3	*—	3.8	16.8	29.0	32.9	23.3
Intervertebral disc disorders	20.4	12.2	*0.2	19.7	42.6	31.5	37.7	22.2
Bone spur or tendinitis, unspecified	13.1	7.2	*1.3	10.9	26.4	24.9	29.9	17.2
Disorders of bone or cartilage	6.6	2.5	*1.5	3.2	8.9	25.1	23.1	30.6
Trouble with bunions	11.1	4.5	*0.4	7.1	22.3	30.6	27.2	35.8
Bursitis, unclassified	20.3	9.8	*1.1	15.3	42.9	43.3	43.5	42.9
Sebaceous skin cyst	5.3	4.6	*2.1	6.1	7.2	6.5	*6.7	*6.3
Trouble with acne	19.9	27.8	24.7	29.8	4.0	*0.7	*1.1	*—
Psoriasis	9.9	6.3	*2.4	8.7	18.6	16.6	16.6	16.6
Dermatitis	40.4	40.6	40.8	40.5	41.4	37.1	42.1	29.7
Trouble with dry (itching) skin, unclassified	21.4	17.6	9.0	23.0	25.8	35.8	30.3	43.9
Trouble with ingrown nails	24.9	19.3	8.5	26.1	31.2	46.5	38.7	53.3
Trouble with corns and calluses	17.6	8.9	*1.0	13.8	33.2	42.1	34.5	53.4
Impairments								
Visual impairment	35.7	22.8	10.4	30.6	48.9	87.0	70.7	111.6
Color blindness	12.6	10.1	4.6	13.6	19.4	15.7	16.4	14.7
Cataracts	26.7	2.1	*0.9	2.8	25.8	166.0	126.1	225.7
Glaucoma	9.9	1.8	*0.8	2.4	12.7	50.5	41.0	64.8
Hearing impairment	94.6	37.4	15.0	51.4	154.2	320.4	257.1	415.3
Tinnitus	30.9	12.4	*1.1	19.5	59.6	69.4	65.3	95.5
Speech impairment	12.3	13.0	20.9	8.0	7.3	16.6	12.6	22.6
Absence of extremities (excludes tips of fingers or toes only)	6.3	2.8	*0.6	4.2	10.3	19.3	19.2	19.6
Paralysis of extremities, complete or partial	5.8	2.8	3.3	2.4	8.2	19.2	14.3	26.4
Deformity or orthopedic impairment	125.7	101.3	32.9	144.3	174.3	185.7	161.7	221.6
Back	74.3	60.6	12.0	91.2	107.0	99.8	89.3	115.6
Upper extremities	17.8	12.9	*2.3	19.6	26.4	31.1	29.6	33.4
Lower extremities	51.0	39.3	19.8	51.6	69.0	68.1	75.0	107.8
Selected digestive conditions								
Ulcer	17.5	12.2	*0.5	19.6	26.5	33.1	36.0	28.7
Hernia of abdominal cavity	20.8	9.0	5.5	11.2	36.5	62.2	59.3	66.5
Gastritis or duodenitis	12.1	7.8	3.1	10.8	19.8	24.1	25.1	22.6
Frequent indigestion	25.3	18.0	3.8	26.9	40.1	43.5	49.0	35.3
Enteritis or colitis	9.8	7.4	2.7	10.3	13.9	16.6	19.9	*11.8
Spastic colon	6.5	4.1	*0.2	6.6	11.7	11.1	13.6	*7.5
Diverticula of intestines	8.4	1.3	*—	2.1	11.8	43.0	44.6	40.7
Frequent constipation	17.1	10.4	6.7	12.8	20.7	48.6	33.7	70.8

See notes at end of table.

Table 57. Number of selected reported chronic conditions per 1,000 persons, by age: United States, 1992—Con.

[Data are based on household interviews of the civilian noninstitutionalized population. The survey design, general qualifications, and information on the reliability of the estimates are given in appendix I. Definitions of terms are given in appendix II]

Type of chronic condition	All ages	Under 45 years				65 years and over		
		Total	Under 18 years	18-44 years	45-64 years	Total	65-74 years	75 years and over
Selected conditions of the genitourinary, nervous, endocrine, metabolic, and blood and blood-forming systems								
Number of chronic conditions per 1,000 persons								
Goiter or other disorders of the thyroid	16.9	8.3	*2.4	12.1	33.4	38.7	40.7	35.7
Diabetes	29.5	7.6	*1.3	11.5	56.0	110.4	113.9	105.3
Anemias	15.3	15.5	10.9	18.4	12.5	16.4	15.6	22.6
Epilepsy	4.5	4.4	2.7	5.4	5.6	*3.2	*3.6	*2.5
Migraine headache	42.3	43.4	13.3	62.4	50.7	22.5	26.4	16.7
Neuralgia or neuritis, unspecified	2.6	*0.9	*0.1	*1.3	4.7	8.7	8.8	*8.4
Kidney trouble	13.4	9.9	3.4	14.0	17.1	27.4	25.8	29.9
Bladder disorders	13.8	9.6	3.7	13.3	17.8	31.3	22.3	44.7
Diseases of prostate	8.1	1.4	*—	2.3	13.6	37.2	38.7	35.1
Disease of female genital organs	18.8	19.9	*2.1	31.2	21.0	8.8	*7.6	*10.6
Selected circulatory conditions								
Rheumatic fever with or without heart disease	8.6	4.7	*0.9	7.0	17.5	16.7	18.5	14.0
Heart disease	85.8	29.3	19.1	35.7	134.9	324.6	271.7	403.9
Ischemic heart disease	32.4	2.8	*—	4.6	61.2	152.7	131.9	183.9
Heart rhythm disorders	32.5	20.4	14.6	24.0	43.5	62.7	68.9	103.5
Tachycardia or rapid heart	8.0	2.5	*0.6	3.7	17.5	23.7	19.1	30.8
Heart murmurs	17.6	15.9	13.3	17.5	18.2	26.6	22.4	32.9
Other and unspecified heart rhythm disorders	6.9	2.0	*0.7	2.9	7.8	32.4	27.5	39.8
Other selected diseases of heart, excluding hypertension	20.9	6.1	4.5	7.2	30.2	69.2	71.0	116.5
High blood pressure (hypertension)	110.6	33.8	*1.1	54.4	226.4	357.6	361.4	352.0
Cerebrovascular disease	13.0	*0.8	*0.2	*1.1	17.3	74.4	65.4	68.0
Hardening of the arteries	9.1	*0.4	*—	*0.7	12.4	52.1	39.6	70.8
Varicose veins of lower extremities	29.0	14.8	*0.4	23.8	52.8	70.9	61.9	64.3
Hemorrhoids	38.0	24.7	*0.2	40.2	71.2	60.0	57.1	64.4
Selected respiratory conditions								
Chronic bronchitis	53.7	49.5	53.6	47.0	53.3	69.6	78.5	56.2
Asthma	49.2	52.1	63.4	44.9	45.0	39.8	43.7	33.9
Hay fever or allergic rhinitis without asthma	102.2	105.8	71.4	127.5	101.6	82.8	84.5	80.3
Chronic sinusitis	145.8	131.8	69.3	171.1	187.3	158.7	157.9	159.9
Deviated nasal septum	7.6	6.0	*0.4	9.5	12.4	6.9	*8.0	*10.4
Chronic disease of tonsils or adenoids	12.1	16.4	28.1	9.0	3.8	*1.3	*2.2	*—
Emphysema	7.6	*0.7	*—	*1.2	15.0	34.6	30.4	40.9

NOTES: The standard errors and relative standard errors (RSE's) can be computed by using parameter set V of table II, the frequencies of table 62, and the formula presented in rule 2 of appendix I. Estimates for which the numerator has an RSE of more than 30 percent are indicated with an asterisk.

Table 61. Number of selected reported chronic conditions per 1,000 persons, by geographic region and place of residence:
United States, 1992

[Data are based on household interviews of the civilian noninstitutionalized population. The survey design, general qualifications, and information on the reliability of the estimates are given in appendix I. Definitions of terms are given in appendix II]

Type of chronic condition	Geographic region				Place of residence			
	Northeast	Midwest	South	West	MSA ¹		Not MSA ¹	
					All MSA ¹	Central city	Not central city	Not MSA ¹
Number of chronic conditions per 1,000 persons								
Selected skin and musculoskeletal conditions								
Arthritis	129.6	154.9	133.3	109.0	122.3	123.0	121.9	169.0
Gout, including gouty arthritis	5.9	6.3	10.6	9.7	7.8	8.0	7.7	10.7
Intervertebral disc disorders	20.6	23.2	17.3	21.9	20.2	16.9	22.3	21.3
Bone spur or tendinitis, unspecified	14.6	13.2	13.3	11.2	12.9	11.6	13.7	13.6
Disorders of bone or cartilage	5.5	8.2	7.5	4.6	6.5	5.9	6.9	7.2
Trouble with bunions	10.2	12.1	9.9	12.7	11.2	11.9	10.8	10.8
Bursitis, unclassified	17.6	24.5	21.1	16.7	19.8	20.1	19.6	22.0
Sebaceous skin cyst	4.9	6.2	4.8	5.4	5.1	4.9	5.2	6.1
Trouble with acne	14.1	23.5	20.3	20.5	19.4	21.0	18.5	21.6
Psoriasis	7.7	12.1	9.6	10.0	9.6	8.0	10.6	11.0
Dermatitis	43.9	40.6	35.4	44.5	41.6	37.1	44.5	36.0
Trouble with dry (itching) skin, unclassified	18.9	28.0	18.0	21.5	20.8	21.6	20.3	23.6
Trouble with ingrown nails	16.7	26.1	30.4	22.9	23.2	27.0	20.8	31.1
Trouble with corns and calluses	18.1	18.5	18.1	15.5	18.0	20.0	16.7	16.3
Impairments								
Visual impairment	33.2	38.5	35.1	35.8	35.6	37.0	34.8	35.9
Color blindness	10.6	13.2	12.5	13.7	13.0	11.0	14.3	11.2
Cataracts	26.9	28.7	27.8	22.8	24.0	27.3	21.8	36.7
Glaucoma	9.4	8.7	12.3	8.0	9.8	11.2	8.9	10.1
Hearing impairment	88.6	107.5	92.6	88.6	85.7	82.1	88.0	126.3
Tinnitus	28.6	35.2	27.4	33.8	28.4	26.5	29.5	40.2
Speech impairment	11.0	12.1	15.7	8.7	12.2	14.5	10.7	12.7
Absence of extremities (excludes tips of fingers or toes only)	6.5	6.1	7.8	3.9	4.8	3.2	5.9	11.4
Paralysis of extremities, complete or partial	6.6	6.5	5.7	4.6	5.8	7.3	4.9	5.7
Deformity or orthopedic impairment	114.1	132.7	116.1	143.1	122.8	122.1	123.2	136.1
Back	63.7	78.5	66.4	91.4	71.5	71.5	71.5	84.4
Upper extremities	15.6	17.5	15.6	23.3	17.2	17.8	16.9	19.6
Lower extremities	47.0	56.8	49.1	51.3	50.3	50.8	50.0	53.6
Selected digestive conditions								
Ulcer	11.7	19.9	19.0	17.9	15.3	18.8	13.1	25.4
Hernia of abdominal cavity	17.9	19.4	26.0	17.0	18.2	16.8	19.1	30.2
Gastritis or duodenitis	13.2	12.8	11.0	12.0	11.8	14.9	9.7	13.4
Frequent indigestion	13.9	28.1	30.3	25.1	24.4	24.6	24.3	28.6
Enteritis or colitis	11.4	9.6	7.9	11.4	10.1	10.5	9.9	8.4
Spastic colon	5.4	7.1	5.8	7.7	5.9	4.9	6.5	8.5
Diverticula of intestines	5.8	8.6	11.7	5.6	8.0	6.9	8.7	10.0
Frequent constipation	14.8	13.4	21.3	16.7	16.7	17.2	16.4	18.3

See notes at end of table.



The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
250 Washington Street, Boston, MA 02108-4619

WILLIAM F. WELD
Governor

ARGEO PAUL CELLUCCI
Lieutenant Governor

GERALD WHITBURN
Secretary

DAVID H. MULLIGAN
Commissioner

July 18, 1996

Dear Interested Parties:

Attached please find a copy of a public health plan developed by the Massachusetts Department of Public Health in collaboration with other agencies involved with public health and environmental concerns. The public health plan was developed to address public health issues on Upper Cape Cod. This plan will be formally presented and discussed at the next U.S. Agency for Toxic Substance and Disease Registry (ATSDR) Community Assistance Panel (CAP) meeting which will be held on August 8th at 7PM at the Quality Inn on Jones Road in Falmouth.

Comments may be sent prior to the meeting to:

Kevin Costas
Bureau of Environmental Health Assessment
Massachusetts Department of Public Health
250 Washington Street
Boston, MA 02108-4619
(617) 624-5757

Sincerely,

A handwritten signature in dark ink, appearing to read "Suzanne U. Condon".

Suzanne Condon, Director
Bureau of Environmental
Health Assessment

Table 61. Number of selected reported chronic conditions per 1,000 persons, by geographic region and place of residence: United States, 1992—Con.

[Data are based on household interviews of the civilian noninstitutionalized population. The survey design, general qualifications, and information on the reliability of the estimates are given in appendix I. Definitions of terms are given in appendix II]

Type of chronic condition	Geographic region				Place of residence			
	Northeast	Midwest	South	West	MSA ¹			
					All MSA ¹	Central city	Not central city	Not MSA ¹
Selected conditions of the genitcurinary, nervous, endocrine, metabolic, and blood and blood-forming systems								
	Number of chronic conditions per 1,000 perscns							
Goiter or other disorders of the thyroid	16.7	16.4	15.9	19.0	17.1	16.4	17.6	15.9
Diabetes	33.4	27.9	33.3	22.0	28.5	31.2	26.7	33.1
Anemias	18.4	10.4	17.1	15.0	15.9	19.8	13.4	12.9
Epilepsy	4.5	3.8	5.9	3.0	4.5	4.9	4.3	4.3
Migraine headache	41.9	39.5	42.0	46.0	42.6	40.6	43.9	41.0
Neuralgia or neuritis, unspecified.	*2.3	*2.6	3.0	*2.2	2.7	2.8	2.6	*2.1
Kidney trouble	8.1	13.1	19.3	9.6	12.2	12.0	12.4	17.7
Bladder disorders	10.1	15.5	14.4	14.4	12.9	15.1	11.5	17.2
Diseases of prostate.	9.4	7.5	8.8	6.8	8.1	7.0	8.9	6.3
Disease of female genital organs.	19.7	21.3	16.4	16.7	19.2	18.6	19.6	17.3
Selected circulatory conditions								
Rheumatic fever with or without heart disease.	9.0	10.6	8.2	6.6	8.2	7.6	8.6	10.0
Heart disease.	89.0	84.3	93.0	73.9	78.4	78.9	78.1	112.6
Ischemic heart disease.	37.4	29.4	37.1	24.3	28.8	25.1	31.2	45.5
Heart rhythm disorders.	32.8	35.0	31.5	30.8	31.0	33.7	29.2	37.7
Tachycardia or rapid heart	8.1	8.3	7.3	8.5	7.2	7.4	7.1	10.6
Heart murmurs	17.8	18.1	18.6	15.4	17.4	20.3	15.6	18.3
Other and unspecified heart rhythm disorders.	6.9	8.6	5.6	6.9	6.3	6.0	6.6	8.6
Other selected diseases of heart, excluding hypertension	18.8	19.9	24.4	18.8	18.6	20.1	17.6	29.4
High blood pressure (hypertension)	105.8	115.4	123.2	90.6	105.0	104.7	105.2	130.9
Cerebrovascular disease.	10.6	12.8	16.7	9.6	11.9	12.6	11.5	16.7
Hardening of the arteries.	8.7	8.0	11.3	7.1	7.7	8.0	7.6	13.9
Varicose veins of lower extremities.	26.0	30.9	27.2	32.0	28.0	26.9	26.6	32.5
Hemorrhoids	34.1	37.9	40.9	37.3	36.3	34.2	37.6	44.3
Selected respiratory conditions								
Chronic bronchitis	48.9	55.5	54.5	54.7	53.6	50.5	55.6	54.0
Asthma.	47.6	49.2	48.2	52.2	50.3	54.8	47.5	45.2
Hay fever or allergic rhinitis without asthma	92.1	92.4	102.0	122.6	105.0	104.7	105.2	92.3
Chronic sinusitis	102.2	169.5	186.6	96.7	139.5	135.0	142.4	168.5
Deviated nasal septum	8.5	7.9	6.5	8.1	8.0	6.9	8.7	6.1
Chronic disease of tonsils or adenoids	8.5	16.2	11.4	11.8	11.4	12.1	11.0	14.5
Emphysema.	7.2	7.7	8.4	6.7	6.5	6.3	6.6	11.7

¹MSA is metropolitan statistical area.

NOTES: The standard errors and relative standard errors (RSE's) can be computed by using parameter set V of table II, the frequencies of tables 66 and 78, and the formula presented in rule 4 of appendix I. Estimates for which the numerator has an RSE of more than 30 percent are indicated with an asterisk.

JONATHAN BOURNE PUBLIC LIBRARY



0 0113 0087104 0

For Reference

Not to be taken from this room

Jonathan Bourne Public Library
19 Sandwich Rd
Bourne, MA 02532